UNIVERSITY of MARYLAND
THE FOUNDING CAMPUS

**ADMINISTRATION & FINANCE**

**OFFICE OF FACILITIES MANAGEMENT**

# SPECIFICATIONS FOR THE DESIGN OF CAMPUS ELECTRICAL DISTRIBUTION AT THE UNIVERSITY OF MARYLAND

**UNIVERSITY PROJECT # 17-317**

**BID DOCUMENTS – PHASES 1B**

**VOLUME 1 OF 1: PROJECT SPECFICATIONS**

**JANUARY 31, 2019**

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**Owner**
University of Maryland, Baltimore
Office of Facilities Management
Design and Construction
220 Arch Street, Office Level 3, 14th Floor
Baltimore, Maryland 21201

**Board of Public Works**
Lawrence J. Hogan Jr., Governor
Peter Franchot, Comptroller
Nancy K. Kopp, Treasurer

**Maryland General Assembly**
Thomas V. Miller Jr, Senate President
Michael Erin Busch, House Speak

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**Architect**
Harris-Kupfer Architects, Inc.
422 N. Howard Street
Baltimore, MD 21201

**Civil/Site Engineer**
Carroll Engineering, Inc.
215 Schilling Circle
Hunt Valley, MD 21031

**Structural Engineer**
Carroll Engineering, Inc.
215 Schilling Circle
Hunt Valley, MD 21031

**MEP Engineer**
RMF Engineering, Inc.
5520 Research Park Drive
Baltimore, MD 21228

**Fire Alarm/ Protection Engineer**
Andes Fire Protection, LLC
22122 Whisperhill Court
Broadlands, VA, 20148

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# SECTION 01010 - SUMMARY OF WORK

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 WORK COVERED BY CONTRACT DOCUMENTS

A. The Project consists of mainly electrical work across the entire campus which will be provided by the contractor. The project has been organized into four packages under one contract:

1. Package A: North Switching Station: The work under this package to be performed by the contractor includes demolition of the existing campus Recycling Center and construction of a new multi-level building in its place. The first level of the North Station will serve as the new campus Recycling Center and the second level will serve as the north switching station with an interstitial level in between for cable management. The contractor will provide five switchgear lineups in the North Station, four of which are for the UMB campus feeders and the fifth for the University of Maryland Medical Center. An additional 15 kV generator paralleling switchgear lineup will be provided by the contractor under the A Package within Howard Hall. A new switchgear control system will be provided by the contractor that will control and monitor the North Station, Howard Hall, and Peaking Plant 15 kV equipment.

   The contractor will provide 15 kV distribution feeders and generation feeders from the North Station and Peaking Plant to the new switchgear provided in Howard Hall. Five total BGE feeders (four for UMB and one for the University of Maryland Medical Center) and associated fiber optic cable from the BGE Paca Street substation to the UMB North Station will be provided by BGE through existing ductbank and shall be coordinated by the contractor.

2. Package B: Howard Hall and Bressler Research Building: The work under this package to be provided by the contractor includes replacing the existing 480 V main building switchgears in Howard Hall and Bressler Research Building and the 4,160 V chiller switchgear in Bressler Research Building. The contractor will provide the Howard Hall Main 15 kV switchgear.

3. Package C: MSTF: The work under this package to be provided by the contractor includes the replacement of the HSF-1 480 V Generator Switchgear with a new paralleling switchgear configured as a main-tie-main. This new HSF1 equipment will utilize the two (2) existing 750kW generators in HSF1 to provide Life-Safety emergency generator power back-up to HSF1, Howard Hall, Bressler Research

Building, and MSTF. The exiting generators located in MSFT will be removed and all existing generator loads will be relocated to a dedicated life-safety load riser for the HSF1 connection. The contractor will provide an additional natural gas generator at the Peaking Plant including and all associated auxiliary equipment to provide a new natural gas line from the existing tap at that location. The Peaking Plant controls system will be replaced by the contractor with a new local control panel and will communicate with the North Switching Station and contain provisions to receive communication from the South Switching Station in the future.

4. Project Location: University of Maryland, Baltimore

5. Owner: University of Maryland, Baltimore.

B. Contract Documents, dated January 31, 2019 were prepared for the Project by:
   1. RMF Engineering: 5520 Research Park Drive, Baltimore, MD 21228
   2. Harris-Kupfer Architects, Inc.: 422 North Howard St, Baltimore, MD 21201.
   3. Carroll Engineering, Inc.: 215 Schilling Circle, Hunt Valley, MD 21031.
   4. Gaudreau, Inc.: 810 Light Street #300, Baltimore, MD 21230.
   5. Andes Fire Protection, LLC: 22122 Whisperhill Court, Broadlands, VA 20148.

1.3 CONTRACTOR USE OF PREMISES

A. General: During the construction period the Contractor shall have full use of the premises for construction operations, including use of the site. The Contractor's use of the premises is limited only by the University's right to perform work or to retain other contractors on portions of the Project.

B. Use of the Site: Limit use of the premises to work in areas indicated. Confine operations to areas within contract limits indicated. Do not disturb portions of the site beyond the areas in which the Work is indicated.

   1. University Occupancy: Allow for University occupancy and use by the public.
   2. Driveways and Entrances: Keep driveways and entrances serving the premises clear and available to the University, the University's employees, and emergency vehicles at all times. Do not use these areas for parking or storage of materials. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.

C. Use of the Existing Building: Maintain the existing building in a weathertight condition throughout the construction period. Repair damage caused by construction operations. Take all precautions necessary to protect the building and its occupants during the construction period.

1.4 OCCUPANCY REQUIREMENTS

A. Full University Occupancy: The University will occupy the site and existing building during the entire construction period. Cooperate with the University during construction operations to minimize conflicts and facilitate University usage. Perform the Work so as not to interfere with the University's operations.
   1. Off Hours Work: All building outages will need to occur during off hours. This includes all building power switchovers and individual load or equipment outages.

1.5 PROTECTION OF EXISTING CONSTRUCTION AND FURNISHINGS

A. The Contractor shall take all necessary precautions to protect the University's property and furnishings. The Contractor shall promptly remedy damage and loss to the University's property caused in whole or in part by the Contractor, a Subcontractor, a Sub-Subcontractor, or anyone directly or indirectly employed by any of them, or by anyone for whose acts they may be liable and for which the Contractor is responsible.

**PART 2 - PRODUCTS** (Not Applicable)

**PART 3 – EXECUTION** (Not Applicable)

END OF SECTION 01010

# SECTION 01027 - APPLICATIONS FOR PAYMENT

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. This Section specifies administrative and procedural requirements governing the Contractor's Applications for Payment.

B. This Section specifies administrative and procedural requirements governing each prime contractor's Applications for Payment.

1. Coordinate the Schedule of Values and Applications for Payment with the Contractor's Construction Schedule, Submittal Schedule, and List of Subcontracts.

C. Related Sections: The following Sections contain requirements that relate to this Section.

1. Schedules: The Contractor's Construction Schedule and Submittal Schedule are specified in Division 1 Section "Submittals."

### 1.3 SCHEDULE OF VALUES

A. Coordination: Coordinate preparation of the Schedule of Values with preparation of the Contractor's Construction Schedule.

1. Correlate line items in the Schedule of Values with other required administrative schedules and forms, including:
   a. Contractor's Construction Schedule.
   b. Application for Payment forms, including Continuation Sheets.
   c. List of subcontractors.
   d. Schedule of allowances.
   e. Schedule of alternates.
   f. List of products.
   g. List of principal suppliers and fabricators.
   h. Schedule of submittals.

2. Submit the Schedule of Values to the University at the earliest possible date but no later than 7 days before the date scheduled for submittal of the initial Applications for Payment.

3. Subschedules: Where Work is separated into phases requiring separately phased payments, provide subschedules showing values correlated with each phase of payment.

B. Format and Content: Use the Project Manual table of contents as a guide to establish the format for the Schedule of Values. Provide at least one line item for each Specification Section.

1. Identification: Include the following Project identification on the Schedule of Values:
   a. Project name and location.
   b. University's Project number.
   c. Contractor's name and address.
   d. 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 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.
   h. Percentage of Contract Sum to nearest one-hundredth percent, adjusted to total 100 percent.
3. Provide a breakdown of the Contract Sum in sufficient detail to facilitate continued evaluation of Applications for Payment and progress reports. Coordinate with the Project Manual table of contents. Break principal subcontract amounts down into several line items.
4. Round amounts to nearest whole dollar; the 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.
   a. Differentiate between items stored on-site and items stored off-site. Include requirements for insurance and bonded warehousing, if required.
6. Provide separate line items on the Schedule of Values for initial cost of the materials, for each subsequent stage of completion, and for total installed value of that part of the Work.
7. Margins of Cost: Show line items for indirect costs and margins on actual costs only when such items are listed individually in Applications for Payment. Each item in the Schedule of Values and Applications for Payment shall be complete. Include the total cost and proportionate share of general overhead and profit margin 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 the Contractor's option.

8. Schedule Updating: Update and resubmit the Schedule of Values prior to the next Applications for Payment when Change Orders or Construction Change Directives result in a change in the Contract Sum.

1.4 APPLICATIONS FOR PAYMENT

A. Each Application for Payment shall be consistent with previous applications for payment as paid for by the University.

1. The initial Application for Payment, the Application for Payment at time of Substantial Completion, and the final Application for Payment involve additional requirements.

B. Refer to the University of Maryland Baltimore Standard General Condition of Construction for requirements and procedures governing applications for payment.

C. Initial Application for Payment: Administrative actions and submittals, that must precede or coincide with submittal of the first Application for Payment, include the following:

1. List of subcontractors.
2. List of principal suppliers and fabricators.
3. Schedule of Values.
4. Contractor's Construction Schedule.
5. Schedule of principal products.
6. Schedule of unit prices.
7. Submittal Schedule.
8. List of Contractor's staff assignments.
9. List of Contractor's principal consultants.
10. Copies of authorizations and licenses from governing authorities for performance of the Work.
11. Initial progress report.
12. Report of preconstruction meeting.
13. Certificates of insurance and insurance policies.
14. Performance and payment bonds.
15. Data needed to acquire the University's insurance.
16. Initial settlement survey and damage report, if required.

D. Application for Payment at Substantial Completion: Following issuance of the Certificate of Substantial Completion, submit an Application for Payment.

1. This application shall reflect Certificates of Partial Substantial Completion issued previously for University occupancy of designated portions of the Work.

2. Administrative actions and submittals that shall precede or coincide with this application include:
   a. Warranties (guarantees) and maintenance agreements.
   b. Test/adjust/balance reports.
   c. Operation and Maintenance Manuals.
   d. Meter readings if appropriate.
   e. Startup performance reports.
   f. Commissioning Reports.
   g. Final cleaning.
   h. Application for reduction of retainage and consent of surety.
   i. Advice on shifting insurance coverages.
   j. Final progress photographs.
   k. List of incomplete Work, recognized as exceptions to University's Certificate of Substantial Completion.

E. Final Payment Application: Administrative actions and submittals that must precede or coincide with submittal of the final Application for Payment include the following:

1. Completion of Project closeout requirements.
2. Completion of items specified for completion after Substantial Completion.
3. Resolve all previously unsettled claims.
4. Resolve all previously incomplete Work.
5. Transmittal of required Project construction records to the University.
6. Proof that taxes, fees, and similar obligations were paid.
7. Removal of temporary facilities and services.
8. Removal of surplus materials, rubbish, and similar elements.
9. Change of door locks to University's access.

**PART 2 - PRODUCTS** (Not Applicable)

**PART 3 - EXECUTION** (Not Applicable)

END OF SECTION 01027

# SECTION 01030 - ALTERNATES

## PART 1 – GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. This Section includes administrative and procedural requirements governing Alternates.
B. Schedule of Alternates:
   1. Add Alternate 1: Provide add alternate for providing the hospital switchgear and associated pad, conduit, and grounding as shown on drawing A-E103.

### 1.3 DEFINITIONS

A. Definition: An alternate is 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 the University decides to accept a corresponding change in either 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 each Alternate into the base Work. No other adjustments are made to the base Contract Sum.

### 1.4 PROCEDURES

A. Coordination: Modify or adjust affected adjacent Work as necessary to completely and fully integrate that Work into the 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 mentioned as part of the Alternate.

B. Notification: Immediately following the award of the Contract, notify each party involved, in writing, of the status of each alternate. Indicate whether 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 this Contract.

## PART 2 - PRODUCTS (Not Applicable)

**PART 3 – EXECUTION** (Not Applicable)

END OF SECTION 01030

# SECTION 01035 - MODIFICATION PROCEDURES

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. This Section specifies administrative and procedural requirements for handling and processing contract modifications.

### 1.3 MINOR CHANGES IN THE WORK

A. The University will issue supplemental instructions authorizing minor changes in the Work, not involving adjustment to the Contract Sum or Contract Time.

### 1.4 CHANGE ORDER PROPOSAL REQUESTS

A. University Initiated Change Order Proposal Requests: The University will issue a detailed description of proposed changes in the Work that will require adjustment to the Contract Sum or Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications.

1. Proposal requests issued by the University are for information only. Do not consider them as an instruction either to stop work in progress or to execute the proposed change.
2. Within a mutually agreed upon time period, submit an estimate of cost necessary to execute the change to the University for review.
    a. Include a list of quantities of products required and unit costs, with the total amount of purchases to be made. Where requested, furnish survey data to substantiate quantities. Include required labor hours and unit costs, with totals for each labor category. Include all credits for deleted work.
    b. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts, for new work and deleted work.
    c. Include a statement indicating the effect the proposed change in the Work will have on the Contract Time.

B. Contractor-Initiated Proposals: When latent or unforseen conditions require modifications to the Contract, the Contractor may propose changes by submitting a request for a change to the University.

1. Include a statement outlining the 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 Contract Time.
2. Include a list of quantities of products required and unit costs, with the total amount of purchases to be made. Where requested, furnish survey data to substantiate quantities. Include required labor hours and unit costs, with totals for each labor category. Include all credits for deleted work.
3. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts, for new work and deleted work.
4. Comply with requirements in Section "Product Substitutions" if the proposed change requires substitution of one product or system for a product or system specified.

C. Proposal Request Form: Use forms provided by the Owner for Change Order Proposals.

1.5 CHANGE ORDER PROCEDURES

A. Upon the University's approval of a Proposal Request, the University will issue a Change Order Requisition for signatures of the Contractor followed by a Notice to Proceed.

**PART 2 - PRODUCTS** (Not Applicable)

**PART 3 - EXECUTION** (Not Applicable)

END OF SECTION 01035

# SECTION 01040 - COORDINATION

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. This Section includes administrative and supervisory requirements necessary for coordinating construction operations including, but not necessarily limited to, the following:

1. General project coordination procedures.
2. Conservation.
3. Coordination Drawings.
4. Administrative and supervisory personnel.
5. Cleaning and protection.

### 1.3 COORDINATION

A. Coordinate construction operations included in various Sections of these Specifications to assure efficient and orderly installation of each part of the Work. Coordinate construction operations included under different Sections that depend on each other for proper installation, connection, and operation.

1. Schedule construction operations in the 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. Coordinate installation of different components to assure required minimum accessibility for maintenance, service, and repair.
3. Make provisions to accommodate items scheduled for later installation.

B. Where necessary, prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and attendance at meetings.

1. Prepare similar memoranda for the University and sub-contractors where coordination of their work is required.

C. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities to avoid conflicts and assure orderly

progress of the Work. Such administrative activities include, but are not limited to, the following:

1. Preparation of CPM schedules.
2. Installation and removal of temporary facilities.
3. Delivery and processing of submittals.
4. Progress meetings.
5. Work coordination meetings.
6. Project closeout activities.

D. Conservation: Coordinate construction operations to assure that operations are carried out with consideration given to conservation of energy, water, and materials.

1. Salvage materials and equipment involved in performance of, but not actually incorporated in, the Work.

1.4 SUBMITTALS

A. Coordination Drawings: Prepare coordination drawings where careful coordination is needed for installation of products and materials fabricated by separate entities. Prepare coordination drawings where limited space availability necessitates maximum utilization of space for efficient installation of different components. At a minimum, prepare coordination drawings for all mechanical rooms, electrical rooms and substation rooms.

1. Show the relationship of components shown on separate Shop Drawings.
2. Indicate required installation sequences.
3. Comply with requirements contained in Section "Submittals."
4. The coordination drawings shall be comprehensive drawings that show all work by all disciplines for each location on a single drawing. The drawings shall be prepared at a large enough scale to permit legibility and ease of recognition of all work.

B. Staff Names: Within 15 days of commencement of construction operations, submit a list of the Contractor's principal staff assignments, including the superintendent and other personnel in attendance at the Project Site. Identify individuals and their duties and responsibilities. List their addresses and telephone numbers.

1. Post copies of the list in the Project meeting room, the temporary field office, and at each temporary telephone.

**PART 2 - PRODUCTS** (Not Applicable)

**PART 3 - EXECUTION**

3.1 GENERAL COORDINATION PROVISIONS

A. Inspection of Conditions: Require the Installer of each major component to inspect both the substrate and conditions under which Work is to be performed. Do not proceed until unsatisfactory conditions have been corrected in an acceptable manner.

B. Coordinate temporary enclosures with required inspections and tests to minimize the necessity of uncovering completed construction for that purpose.

## 3.2 CLEANING AND PROTECTION

A. Clean and protect construction in progress and adjoining materials in place, during handling and installation. Apply protective covering where required to assure protection from damage or deterioration until Substantial Completion.

B. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to assure operability without damaging effects.

C. 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. Where applicable, such exposures include, but are not limited to, the following:

1. Excessive static or dynamic loading.
2. Excessive internal or external pressures.
3. Air contamination or pollution.
4. Water or ice.
5. Puncture.
6. Abrasion.
7. Heavy traffic.
8. Soiling, staining, and corrosion.
9. Combustion.
10. Electrical current.
11. Improper lubrication.
12. Unusual wear or other misuse.
13. Contact between incompatible materials.
14. Destructive testing.
15. Misalignment.
16. Excessive weathering.
17. Unprotected storage.
18. Improper shipping or handling.
19. Theft.
20. Vandalism.

END OF SECTION 01040

# SECTION 01045 - CUTTING AND PATCHING

## PART 1 – GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. This Section includes administrative and procedural requirements for cutting and patching.

### 1.3 SUBMITTALS

A. Cutting and Patching Proposal: When unforeseen conditions require cutting and patching of the existing structure and/or related components the CM shall submit a cutting and patching proposal to the university, for review and approval before proceeding with any work. Include the following information, as applicable, in the proposal:

1. Describe the extent of cutting and patching required and indicate why it cannot be avoided. Include changes to the building's appearance and other significant visual elements if applicable.
2. Describe the products to be used.
3. Identify the impact to the project’s schedule and budget.
4. Indicate the dates when cutting and patching will be performed.
5. Where cutting and patching involves adding reinforcement to structural elements, the modifications to the structure shall be designed by a registered structural engineer. If the design team does not include a structural engineer the CM shall secure the services of an engineer to perform the required design. The CM shall submit the design drawings, details and engineering calculations showing integration of reinforcement with the original structure to the University.
6. Approval by the University to proceed with cutting and patching does not waive the University's right to later require complete removal and replacement of unsatisfactory work.

### 1.4 QUALITY ASSURANCE

A. Requirements for Structural Work: Do not cut and patch structural elements in a manner that would change their load-carrying capacity or load-deflection ratio.

1. Obtain hot work permit from the University for cutting, burning, welding, etc.
2. Obtain approval of the cutting and patching proposal before cutting and patching the following structural elements:
   a. Foundation construction.

b. Bearing and retaining walls.
c. Structural concrete.
d. Structural steel.
e. Lintels.
f. Timber and primary wood framing.
g. Structural decking.
h. Stair systems.
i. Miscellaneous structural metals.
j. Exterior curtain-wall construction.
k. Equipment supports.
l. Piping, ductwork, vessels, and equipment.
m. Structural systems of special construction in Division 13 Sections.

B. Operational Limitations: Do not cut and patch operating elements or related components in a manner that would result in reducing their capacity to perform as intended. Do not cut and patch operating elements or related components in a manner that would result in increased maintenance or decreased operational life or safety.
1. Obtain approval of the cutting and patching proposal from the University before cutting and patching the following operating elements or safety related systems:
a. Primary operational systems and equipment.
b. Air or smoke barriers.
c. Water, moisture, or vapor barriers.
d. Membranes and flashings.
e. Fire protection systems.
f. Noise and vibration control elements and systems.
g. Control systems.
h. Communication systems.
i. Conveying systems.
j. Electrical wiring systems.
k. Operating systems of special construction.

C. Visual Requirements: Do not cut and patch construction exposed on the exterior or in occupied spaces in a manner that would, in the University's opinion, reduce the building's aesthetic qualities. Do not cut and patch construction in a manner that would result in visual evidence of cutting and patching. Remove and replace construction cut and patched in a visually unsatisfactory manner when directed by the University.

1. If possible, retain the original Installer or fabricator to cut and patch the exposed Work listed below. If it is impossible to engage the original Installer or fabricator, engage another recognized experienced and specialized firm.
a. Processed concrete finishes.
b. Stonework and stone masonry.
c. Ornamental metal.
d. Matched-veneer woodwork.
e. Preformed metal panels.

f. Firestopping.
g. Window wall system.
h. Stucco and ornamental plaster.
i. Acoustical ceilings.
j. Terrazzo.
k. Finished wood flooring.
l. Fluid-applied flooring.
m. Carpeting.
n. Aggregate wall coating.
o. Wall covering.
p. HVAC enclosures, cabinets, or covers.

1.5 WARRANTY

A. Existing Warranties: Replace, patch, and repair material and surfaces cut or damaged by methods and with materials in such a manner as not to void any warranties required or existing.

**PART 2 - PRODUCTS**

2.1 MATERIALS, GENERAL

A. Use materials identical to existing materials. For exposed surfaces, use materials that visually match existing adjacent surfaces to the fullest extent possible if identical materials are unavailable or cannot be used. Use materials whose installed performance will equal or surpass that of existing materials. Refer to applicable spec sections for materials.

**PART 3 - EXECUTION**

3.1 INSPECTION

A. Examine surfaces to be cut and patched and conditions under which cutting and patching is to be performed before cutting. If unsafe or unsatisfactory conditions are encountered, take corrective action before proceeding.

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 the Project that might be exposed during cutting and patching operations.

C. Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.

D. Avoid cutting existing pipe, conduit, or ductwork serving the building but scheduled to be removed or relocated until provisions have been made to bypass them or to take them out of service.

3.3 PERFORMANCE

A. General: Employ skilled workmen or experienced subcontractors 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 activities and the subsequent fitting and patching required to restore surfaces to their original condition.

B. Cutting: Cut existing construction using methods least likely to damage elements retained or adjoining construction. Where possible, review proposed procedures with the original Installer; comply with the original Installer's recommendations.

1. In general, when cutting, use hand or small power tools designed for sawing or 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. To avoid marring existing finished surfaces, cut or drill from the exposed or finished side into concealed surfaces.
3. Cut through concrete and masonry using a cutting machine, such as a Carborundum saw or a diamond-core drill.
4. Comply with requirements of applicable Division 2 Sections where cutting and patching requires excavating and backfilling.
5. Where services are required to be removed, relocated, or abandoned, by-pass utility services, such as pipe or conduit, before cutting. Ensure all services have been de-energized or drained before cutting. Cut-off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal the remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after by-passing and cutting.

C. Patching: Patch with durable seams that are as invisible as possible. Comply with specified tolerances.

1. Where feasible, inspect and test patched areas to demonstrate integrity of the installation.
2. 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. Where removing walls or partitions extends one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of

uniform color and appearance. Remove existing floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.

a. Where patching occurs in a smooth painted surface, extend final paint coat over entire unbroken surface containing the patch after the area has received primer and second coat. Prepare entire surface to receive final coat as necessary for proper adhesion.

4. Patch, repair, or rehang existing ceilings as necessary to provide an even-plane surface of uniform appearance.

D. Plaster Installation: Comply with manufacturer's instructions and install thickness and coats as indicated.

1. Unless otherwise indicated, provide 3-coat work.
2. Finish gypsum plaster to match existing adjacent surfaces. Sand lightly to remove trowel marks and arises.
3. Cut, patch, point-up, and repair plaster to accommodate other construction.

3.4 LEANING

A. Areas and spaces where cutting, and patching are performed shall be cleaned. Completely remove paint, mortar, oils, putty, and similar items. Thoroughly clean piping, conduit, and similar features before applying paint or other finishing materials. Restore damaged pipe covering to its original condition.

END OF SECTION 01045

# SECTION 01095 - REFERENCE STANDARDS AND DEFINITIONS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 DEFINITIONS

A. General: Basic contract definitions are included in the Conditions of the Contract.

B. "Indicated": The term "indicated" refers to graphic representations, notes, or schedules on the Drawings, or other paragraphs or Schedules in the Specifications, and similar requirements in the Contract Documents. Terms such as "shown," "noted," "scheduled," and "specified" are used to help the reader locate the reference. Location is not limited.

C. "Directed": Terms such as "directed," "requested," "authorized," "selected," "approved," "required," and "permitted" mean directed by the University, requested by the University, and similar phrases.

D. "Approved": The term "approved," when used in conjunction with the University's action on the Contractor's submittals, applications, and requests, is limited to the University's duties and responsibilities as stated in the Conditions of the Contract.

E. "Regulations": The term "regulations" includes laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, as well as rules, conventions, and agreements within the construction industry that control performance of the Work.

F. "Furnish": The term "furnish" means supply and deliver to the Project Site, ready for unloading, unpacking, assembly, installation, and similar operations.

G. "Install": The term "install" describes operations at the Project Site including the actual unloading, unpacking, assembly, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.

H. "Provide": The term "provide" means to furnish and install, complete and ready for the intended use.

I. "Installer": An installer is the Contractor or another entity engaged by the Contractor, either as an employee, subcontractor, or contractor of lower tier, to perform a particular construction activity, including installation, erection, application, or similar operations. Installers are required to be experienced in the operations they are engaged to perform.

1. The term "experienced," when used with the term "installer," means having a minimum of 5 previous projects similar in size and scope to this Project, being familiar with the special requirements indicated, and having complied with requirements of authorities having jurisdiction.
2. Trades: Using terms 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 tradespersons of the corresponding generic name.

J. “Project Site" is the space available to the Contractor for performing construction activities, either exclusively or in conjunction, with others performing other work as part of the Project. The extent of the Project Site is shown on the Drawings and may or may not be identical with the description of the land on which the Project is to be built.

K. “Testing Agencies": A testing agency is an independent entity engaged to perform specific inspections or tests, either at the Project Site or elsewhere, and to report on and, if required, to interpret results of those inspections or tests.

## 1.3 INDUSTRY STANDARDS

A. Applicability of Standards: Except where 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 the standards in effect as of the date of the Contract Documents.

C. Conflicting Requirements: Where compliance with 2 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 to the University before proceeding for a decision on requirements that are different but apparently equal, and where it is uncertain which requirement is the most stringent.

1. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum acceptable. 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 the requirements. Refer uncertainties to the University for a decision before proceeding.

D. Copies of Standards: Each entity engaged in construction on the Project is required to 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, the Contractor shall obtain copies directly from the publication source.

E. Abbreviations and Names: Trade association names and titles of general standards are frequently abbreviated. Where such acronyms or abbreviations are used in the Specifications or other Contract Documents, they mean the recognized name of the trade association, standards-generating organization, authorities having jurisdiction, or other entity applicable to the context of the text provision. Refer to Gale Research Co.'s "Encyclopedia of Associations," available in most libraries.

1.4 SUBMITTALS

A. Permits, Licenses, and Certificates: For the University'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 in conjunction with compliance with standards and regulations bearing upon performance of the Work.

**PART 1 - PRODUCTS** (Not Applicable)

**PART 2 - EXECUTION** (Not Applicable)

END OF SECTION 01095

# SECTION 01200 - PROJECT MEETINGS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. This Section specifies administrative and procedural requirements for project meetings, including, but not limited to, the following:
   1. Preconstruction conferences.
   2. Progress meetings.

### 1.3 PRECONSTRUCTION CONFERENCE

A. The University shall schedule a preconstruction conference before starting construction, at a time convenient to the Contractor and the University, but no later than 15 days after execution of the Agreement. The conference will be held at a site identified by the University.

   1. The University will conduct the meeting. Minutes will be recorded and distributed to participants in accordance with contract requirements.

B. Attendees: Authorized representatives of the University, University, and their consultants; the Contractor and its superintendent; major subcontractors; and other concerned parties shall attend the conference. All participants at the conference shall be familiar with the Project and authorized to conclude matters relating to the Work.

C. Agenda: Discuss items of significance that could affect progress, including, but not limited to, the following:

   1. Tentative construction schedule.
   2. Critical work sequencing.
   3. Designation of responsible personnel.
   4. Procedures for processing field decisions and Change Orders.
   5. Procedures for processing Applications for Payment.
   6. Procedures for processing Requests for Information (RFI's).
   7. Procedures for processing University's Supplemental Instructions and Contract Clarification.
   8. Distribution of Contract Documents.
   9. Submittal of Shop Drawings, Product Data, and Samples.
   10. Preparation of record documents.
   11. Use of the premises.
   12. Parking availability.

13. Office, work, and storage areas.
14. Equipment deliveries and priorities.
15. Safety procedures.
16. First aid.
17. Security.
18. Housekeeping.
19. Working hours.
20. Utility outages.
21. Testing.

1.4 PROGRESS MEETINGS

A. The University shall schedule and administer bi-weekly progress meetings throughout the progress of work. The progress meetings will be held at a site identified by the University.

1. The University will conduct the meeting, record minutes, and distribute copies to participants.

B. Attendees: In addition to representatives of the University and the University, each subcontractor, or 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 the Project and authorized to conclude matters relating to the Work.

C. Agenda: Review and correct or approve minutes of the previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to the status of the Project.

1. Contractor's CPM Construction Schedule: Review progress since the last meeting. Determine status of each activity in relation to the Contractor's Construction Schedule, whether on time, ahead or behind schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to insure that current and subsequent activities will be completed within the Contract Time. Determine status of tasks on critical path. Identify additional tasks becoming critical due to delays.
2. Review the present and future needs of each entity present, including, but not limited to, the following:
    a. Interface requirements.
    b. Time.
    c. Sequences.
    d. Status of submittals.
    e. Deliveries.
    f. Off-site fabrication problems.
    g. Access.
    h. Site utilization.

i. Temporary facilities and services.
j. Hours of work.
k. Hazards and risks.
l. Housekeeping.
m. Quality and work standards.
n. Change Orders.
o. Documentation of information for payment requests.
p. Review submittal log.
q. Review RFI log.
r. Review Change Order log.
s. Review upcoming outages, testing and inspections.

**PART 2 - PRODUCTS** (Not Applicable)

**PART 3 - EXECUTION** (Not Applicable)

END OF SECTION 01200

# SECTION 01300 - SUBMITTALS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. This Section includes administrative and procedural requirements for all submittals, required for the installation and completion of the work for the project. Submittals include three (3) types of submittals, Construction Submittals, Administrative Submittals and Quality Control Submittals as defined hereinafter.

B. UM Standard Project Forms:

1. The CM, Contractors, and A/E shall use the following UM Standard Project Submittal Forms for all submissions as follows:

   a. UM Standard Project Submittal Form
   b. UM Standard Project RFI Form

2. These forms are included in Part 2 Products for reference and each form's individual electronic file is available at the UM Architecture Engineering and Construction Documents web site at http://www.umbfm.umaryland.edu then through the link for AEC and AEC Documents.

### 1.3 DEFINITIONS

A. Construction Submittals: Construction Submittals are defined as submittals which include all information related to products, materials, and equipment used for the construction of the project. Unless otherwise indicated all references to "Submittals" in the documents are for Construction Submittals. Construction Submittals: Such submittals shall include, but are not limited to, the following:
   1. Contractor's construction schedule.
   2. Submittal schedule.
   3. Daily construction reports.
   4. Shop Drawings.
   5. Product Data.
   6. Samples.
   7. Quality assurance submittals.
   8. Fabrication drawings.
   9. Installation drawings.

10. Setting diagrams.
11. Shopwork manufacturing instructions.
12. Templates and patterns.
13. Schedules.
14. Coordination drawings.
15. Requests for Information (RFI's).

B. Administrative Submittals: Administrative Submittals are defined as submittals which include all information related to administrative documentation for the project. Refer to other Division 1 Sections and other Contract Documents for requirements for administrative submittals. Such submittals shall include, but are not limited to, the following:
   1. Permits.
   2. Applications for Payment.
   3. Performance and payment bonds.
   4. Insurance certificates.
   5. List of subcontractors.

C. Quality Control Submittals: Quality-control submittals are defined as submittals which include all information related to administrative documentation for the project. Such submittals shall include, but are not limited to, the following:

   1. Design data.
   2. Certifications.
   3. Manufacturer's instructions.
   4. Manufacturer's field reports.

D. Coordination Drawings: Coordination Drawings show the relationship and integration of different construction elements that require careful coordination during fabrication or installation to fit in the space provided or to function as intended.

   1. Preparation of Coordination Drawings is specified in Division 1 Section "Coordination" and may include components previously shown in detail on Shop Drawings or Product Data.

E. Samples: Samples include, but are not limited to, the following:
   1. Partial Sections of manufactured or fabricated components.
   2. Small cuts or containers of materials.
   3. Complete units of repetitively used materials.
   4. Swatches showing color, texture, and pattern.
   5. Color range sets.
   6. Components used for independent inspection and testing.
   7. Field samples.
   8. Field mock-ups

F. Product Data: Product data shall include, but are not limited to, the following:

1. Manufacturer's product specifications.
2. Manufacturer's installation instructions.
3. Standard color charts.
4. Catalog cuts.
5. Roughing-in diagrams and templates.
6. Standard wiring diagrams.
7. Printed performance curves.
8. Operational range diagrams.
9. Mill reports.
10. Standard product operating and maintenance manuals.
11. Certified capacity and performance data.

## 1.4 GENERAL SUBMITTAL PROCEDURES

A. Submissions: UM requires that all construction and administration type submittals be transmitted electronically in "pdf" format for all products, materials, and equipment related to construction and all documentation related to the administration of the project. However UM will accept hard copies (paper copies) of construction and administration type submittals from the Contractor and CM when electronic files cannot be used.

B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities. Transmit each submittal sufficiently in advance of performance of related construction activities to avoid delay, and in accordance with the project CPM schedule.

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 elements of the Work so processing will not be delayed by the need to review submittals concurrently for coordination.

   a. The University reserves the right to withhold action on a submittal requiring coordination with other submittals until all related submittals are received.

3. Scheduling: Division 1 Section "Schedules and Reports" includes the Submittal Schedule listing submittals and indicating time requirements for coordination of submittal activity with related construction operations.

4. Processing: To avoid the need to delay installation as a result of the time required to process submittals, allow sufficient time for submittal review, including time for resubmittals.

a. Allow four (4) weeks for initial review. Allow additional time if the University must delay processing to permit coordination with subsequent submittals.
b. If an intermediate submittal is necessary, process the same as the initial submittal.
c. Allow four (4) weeks for reprocessing each submittal.
d. No extension of Contract Time will be authorized because of failure to transmit submittals to the University sufficiently in advance of the Work to permit processing.
e. The Contractor and CM shall conduct an internal review of every submittal to ensure accuracy and completeness prior to submission to the A/E.

C. Submittal Preparation: The Contractor or CM shall attach the UM Standard Project Submittal Form to the electronic file for each submittal. The contractor or CM shall complete the upper portion of the forms as appropriate.

D. Submittal Transmittal: Include an electronic transmittal with each submittal file for transmittal and handling. Each submittal file shall be transmitted electronically from the Contractor to the CM, then to the A/E. Forward a copy of the electronic transmittal to the UM OFM Project Manager. The A/E and the University will not accept submittals received from sources other than the Contractor or CM.

1. On the transmittal, record relevant project information.
2. Include Contractor's certification that information submitted complies with Contract Document requirements.
3. Transmittal Form: Prepare. Use the UM Standard Submittal Transmittal Form. In the places on the form provide the following information:

a. Project name.
b. Date.
c. Destination (To:).
d. Source (From:).
e. Names of the subcontractor, manufacturer, and supplier.
f. Category and type of submittal.
g. Submittal purpose and description.
h. Submittal and transmittal distribution record.
i. Remarks.
j. Signature of transmitter.

E. Requests for Information (RFI's): Use the UM Standard RFI Form for all Requests for Information. The CM or contractor shall submit each RFI to the A/E and copy the UM OFM Project Manager.

F. Contractor's Construction Schedule: Refer To Division 1 Section CPM Schedules

G. Daily Construction Reports

1. Prepare a daily construction report recording the following information concerning events at the site, and submit duplicate copies to the University at weekly intervals:

   a. List of subcontractors at the site.
   b. Approximate count of personnel at the site.
   c. High and low temperatures, general weather conditions.
   d. Accidents and unusual events.
   e. Meetings and significant decisions.
   f. Stoppages, delays, shortages, and losses.
   g. Meter readings and similar recordings.
   h. Incident reports with emergency procedures followed.
   i. Orders and requests of governing authorities.
   j. Change Orders received, implemented.
   k. Services connected, disconnected.
   l. Equipment or system tests and startups.
   m. Partial Completions, occupancies.
   n. Substantial Completions authorized.

H. Shop Drawings and Coordinated Drawings

1. In addition to the general submittal procedures, the following requirements apply to shop drawings and coordination drawings:

   a. Submit newly prepared information drawn accurately to scale. Indicate deviations from the Contract Documents. The CM or contractor shall not reproduce Contract Documents or copy standard information as the basis of Shop Drawings. Standard information prepared without specific reference to the Project is not a Shop Drawing.

2. Shop Drawings include fabrication and installation drawings, setting diagrams, schedules, patterns, templates and similar drawings. Include the following information:

   a. Dimensions.
   b. Identification of products and materials included by sheet and detail number.
   c. Compliance with specified standards.
   d. Notation of coordination requirements.
   e. Notation of dimensions established by field measurement.

3. Submit Coordination Drawings where required for integration of different construction elements, and in compliance with the requirements of Division 1 Section “Coordination”. Show construction sequences and relationships of separate components where necessary to avoid conflicts in utilization of the space available.

4. 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).

5. Hard Copy Submittals: When hard copy submittals are used submit one (1) reproducible drawing for review by the A/E. The A/E will review and make appropriate comments on the reproducible drawing, sign off the UM forms with action taken, make one (1) print for their record, and forward the reproducible drawing to the University. The University will review and make additional comments as necessary, forward their comments to the A/E for their record and information, make one (1) copy for their use and return the reproducible drawing to the Contractor. For submittals requiring resubmission, the process will be repeated until submittals are considered acceptable by the A/E and the University.

6. Electronic Submittals: When shop drawings are transmitted electronically, submit one (1) electronic file for each shop drawing. Each file shall include all required submittal data and the UM Submittal Form for each submittal. The A/E will review and make appropriate comments on the electronic file, sign off the UM forms with action taken, retain one (1) copy for their record, and forward the electronic file to the University. The University will review and make additional comments as necessary; forward their comments to the A/E for their record and information, retain one (1) copy of the electronic file for their use, and return the electronic file to the CM or Contractor. For submittals requiring resubmission, the process will be repeated until submittals are considered acceptable by the A/E and the University.

7. Shop Drawing shall not be used without an appropriate final stamp indicating the action taken.

I. Product Data

1. In addition to the general submittal procedures, the following requirements apply to product data submittals:

   a. Collect Product Data into a single submittal for each element of construction or system. Product Data shall include printed information, such as manufacturer's general product information, installation instructions, catalog cuts, standard color charts, roughing-in dimensions, diagrams and templates, standard wiring diagrams, and performance data and curves.

   b. Mark each copy to show applicable choices and options. Where printed product data includes information on several products that are either not required or are optional materials, arrangements or components that require

a selection or indicator, mark copies to indicate the applicable information. Include the following information:

1) Manufacturer's printed recommendations.
2) Compliance with trade association standards.
3) Compliance with recognized testing agency standards.
4) Application of testing agency labels and seals.
5) Notation of dimensions verified by field measurement.
6) Notation of coordination requirements.
7) Compliance with contract documents.
8) Specification Section and paragraph.

c. Do not submit Product Data until compliance with requirements of the Contract Documents has been confirmed.

d. Hard Copy Submittals: When hard copy submittals are used submit six (6) copies, plus the number required for the CM and Contractor's use, of each required submittal for review by the A/E. The A/E will review and make appropriate comments on each copy, sign off the UM forms with action taken, retain two (2) copies for their records and forward the remaining submittals to the University. The University will review the submittals, make additional comments as necessary, forward their comments to the A/E for their records, retain one (1) copy of each submittal, and return the remaining submittals to the Contractor. For submittals requiring resubmission, the process will be repeated until submittals are considered acceptable by the A/E and the University.

e. Electronic Submittals: When product data submittals are transmitted electronically, submit one (1) electronic file for each shop submittal. Each file shall include all required submittal data and the UM Submittal Form for each submittal. The A/E shall review and make appropriate comments on the electronic file, sign off the UM forms with action taken, retain one (1) copy for their record and forward the electronic file to the University. The University will review and make additional comments as necessary, sign off the UM forms, retain one (1) copy of the electronic file for their use, forward their comments to the A/E for their record and information, and return the electronic file to the CM or Contractor. For submittal files requiring resubmission, the process will be repeated until submittals are considered acceptable by the A/E and the University.

f. Distribution: Forward one (1) copy of each approved submittal file to installers, subcontractors, suppliers, manufacturers, fabricators, and others required for performance of construction activities. Show distribution on transmittal forms.

g. Do not proceed with installation until a copy of approved Product Data is in the Installer's possession.

h. Do not permit use of unmarked copies of Product Data in connection with construction.

i. The Contractor shall retain three (3) copies of the final submittals for inclusion in the O&M Manuals.

J. Samples

1. In addition to the general submittal procedures, the following requirements apply to samples:

a. Submit full-size, fully fabricated Samples cured and finished as specified and physically identical with the material or product designed and specified. Samples include partial sections of manufactured or fabricated components, cuts or containers of materials, color range sets, and swatches showing color, texture, and pattern.

b. Mount or display Samples in a manner to facilitate review of qualities indicated. Include the following:

1) Specification Section number and reference.
2) Generic description of the Sample.
3) Sample source.
4) Product name or name of the manufacturer.
5) Compliance with recognized standards.
6) Availability and delivery time.
7) Size limitations.
8) Compliance with governing regulations.

c. Submit Samples for review of size, kind, color, pattern, and texture. Submit Samples for a final check of these characteristics with other elements and a comparison of these characteristics between the final submittal and the actual component as delivered and installed.

1) Where variation in color, pattern, texture, or other characteristic is inherent in the material or product represented, submit at least three (3) multiple units that show approximate limits of the variations.
2) Refer to other Specification Sections for requirements for Samples that illustrate workmanship, fabrication techniques, & details of assembly, connections, operation, and similar construction characteristics.

3) Refer to other Sections for Samples to be returned to the Contractor for incorporation in the work. Such Samples must be undamaged at time of use. On the transmittal, indicate special requests regarding disposition of Sample submittals.
4) Samples not incorporated into the work or otherwise designated as the University's property, are the property of the Contractor and shall be removed from the site prior to Substantial Completion.

d. Submittals: Submit three (3) sets. The A/E will retain one (1) set and send two (2) sets marked with the action taken to the University. The University will retain one (1) set and return the other set to the CM or Contractor.

e. Maintain sets of Samples, as returned, at the project Site, for quality comparisons throughout the course of construction.

1) Unless noncompliance with Contract Document provisions is observed, the submittal may serve as the final submittal.
2) Approved sample sets will be used by the A/E and the University to determine final acceptance of the construction associated with each set.

K. Quality Assurance Submittals

1. In addition to the general submittal procedures, the following requirements apply to quality assurance submittals:

a. Submit quality-control submittals, including design data, certifications, manufacturer's instructions, manufacturer's field reports, and other quality-control submittals as required under other Sections of the Specifications.

b. Certifications: Where other Sections of the Specifications require certification that a product, material, or installation complies with specified requirements, submit a notarized certification from the manufacturer certifying compliance with specified requirements.

c. Signature: Certification shall be signed by an officer of the manufacturer or other individual authorized to sign documents on behalf of the company.

d. Inspection and Test Reports: Requirements for submittal of inspection and test reports from independent testing agencies are specified in Division 1 Section "Quality Control."

L. Architect/Engineer’s (A/E) Action

1. The A/E will review each submittal, mark to indicate action taken, and transmit the submittals promptly to the UM OFM Project Manager.

a. Compliance with the contract documents is the Contractor's responsibility.

2. Submittal Action: The A/E will fill in the appropriate boxes on the UM Standard Project Submittal Form attached to each submittal and attach their comments as necessary. The University will fill in the lower portion of the form as necessary on each submittal to indicate the University has reviewed the submittals. The A/E's submittal stamp shall not be used on submittals for UM projects.

M. Construction Manager's (CM) or Contractor Action

1. The CM or Contractor shall be responsible for the collection of all project submittals from the suppliers and subcontractors for distribution to the A/E and the University for review. The CM is responsible for the redistribution of the reviewed submittals back to the subcontractors and suppliers for appropriate action based on the A/E and University review comments.
2. Submittal Action: The UM Standard Project Submittal Form will indicate how the CM or Contractor needs to proceed with each submittal as follows:

a. Action – "No Exceptions Taken": Submittals returned to the CM or Contractor as "No Exceptions Taken" indicates the submitted material and equipment appears to comply with requirements of the Contract Documents and therefore the work related to the submittal can proceed. Final payment depends on that compliance.

b. Action – "Note Markings/Attachments": Submittals returned to the CM or Contractor as "Note Markings/Attachments" indicates the submitted material and equipment will appear to comply with requirements of the Contract Documents provided the noted comments become a part of the submission and therefore the work related to the submittal can proceed. Final payment depends on that compliance.

c. Action – "Amend & Resubmit": Submittals returned to the CM or Contractor as "Amend & Resubmit" indicates some of the submitted material and equipment does not comply with the requirements of the Contract Documents and therefore the work related to the submittal cannot proceed until the re-submittal process confirms that the material and equipment complies with the requirements of the Contract Documents. Final payment depends on that compliance.

d. Action–"Rejected/Resubmit": Submittals returned to the CM or Contractor as "Rejected/Resubmit" indicates that there are significant and fundamental deficiencies indicated in the submitted material and equipment, and does not comply with the requirements of the Contract Documents. Therefore the work related to the submittal cannot proceed until the re-submittal process

confirms that the material and equipment complies with the requirements of the Contract Documents. Final payment depends on that compliance.

3. When the CM or Contractor receives submittals as “Amend & Resubmit” or “Rejected/Resubmit," the CM or Contractor shall not proceed with work covered by these submittals, including purchasing, fabrication, delivery, or other activity. Revise or prepare new submittals according to the notations; resubmit without delay. Repeat as necessary to obtain acceptance from the A/E and UM.

4. Do not use, or allow others to use, submittals marked “Amend & Resubmit" or “Rejected/Resubmit” at the Project Site or elsewhere where work is in progress.

5. Other Action: Where a submittal is for information or record purposes or special processing or other activity, the University will return the submittal marked "Action Not Required."

**PART 2 - PRODUCTS** (Not Applicable)

**PART 3 - EXECUTION**

3.1 UM STANDARD PROJECT SUBMITTAL FORM

A. The electronic file for this form is available at the UM Architecture Engineering and Construction Documents web site.

**UMB STANDARD PROJECT SUBMITTAL FORM**

UMB PROJECT NAME: _____

UMB PROJECT NUMBER: _____ UM SYSTEM CAMPUS: _____

| | |
|---|---|
| CONTRACTOR:<br>Submission is in compliance with contract requirements, including dimensions, quantities and all trade coordination.<br><br>___Submitted as specified<br>___Substitution in accordance with ***Insert Spec Section Here***<br><br>Date: ___/___/___ By:_____ | C M:<br>Submittal No. _____<br>***Insert Submittal # above***<br>___Submission to the University and AE is in accordance with ***Contract Insert Contract No. Here***<br>___Disapproved<br><br>Date: ___/___/___ By:_____ |
| PROJECT ARCH:<br>__ No Exceptions Taken __Note Markings/Attachments<br>__Amend & Resubmit __Rejected/Resubmit<br><br>Review of the submission by the Architect is in accordance with and governed by the Architect Agreement ***Insert Contact # here.*** For explanation of the Architect's review comments, refer to Section ***Insert Spec Section here*** of the Specifications.<br><br>Date: ___/___/___ By:_____ | ASSOCIATED ARCH:<br>__ No Exceptions Taken __Note Markings/Attachments<br>__Amend & Resubmit __Rejected/Resubmit<br><br>Date: ___/___/___ By:_____ |
| CIVIL ENGINEER:<br>__ No Exceptions Taken __Note Markings/Attachments<br>__Amend & Resubmit __Rejected/Resubmit<br><br>Date: ___/___/___ By:_____ | STRUCTURAL ENGINEER:<br>__ No Exceptions Taken __Note Markings/Attachments<br>__Amend & Resubmit __Rejected/Resubmit<br><br>Date: ___/___/___ By:_____ |
| MEP ENGINEER:<br>__ No Exceptions Taken __Note Markings/Attachments<br>__Amend & Resubmit __Rejected/Resubmit<br><br>Date: ___/___/___ By:_____ | CONSULTANT<br>__ No Exceptions Taken __Note Markings/Attachments<br>__Amend & Resubmit __Rejected/Resubmit<br><br>Date: ___/___/___ By:_____ |
| OWNER:<br>Date: ___/___/___ Regional Review By:_____<br><br>Date: ___/___/___ UMB Review By:_____<br>Owner Comments: _____<br>_____<br>_____<br>Review by Owner does not relieve the CM and/or AE of their obligations under the above noted contracts respectively. | |

3.2 UM STANDARD PROJECT RFI FORM

A. The electronic file for this form is available at the UM Architecture Engineering and Construction Documents web site.

**UMB STANDARD REQUEST FOR INFORMATION FORM**

| | |
|---|---|
| **REQUEST FOR INFORMATION (RFI) No.:** | **Date:** |
| **Subject:** | **UMB Project Title:** |
| **Discipline:** | **UMB Project No.:** |
| **Specification Reference:** | **Importance:** |
| **Drawing Reference:** | **Return RFI By:** |

**Information Requested:**

| | |
|---|---|
| **Requested By:** | **Date Requested:** |

**Contractors Proposed Solution:**

| | |
|---|---|
| **Submitted By:** | **Date Submitted:** |

**A/E Response:**

| | |
|---|---|
| **Reviewed By:** | **Date Reviewed:** |

**UMB Response:**

| | |
|---|---|
| **Reviewed By:** | **Date Reviewed:** |

END OF SECTION 01300

# SECTION 01311 - SCHEDULES AND REPORTS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. This Section includes administrative and procedural requirements for schedules, reports, and critical path method scheduling required for proper performance of the Work, including:

1. Submittal schedule.
2. Schedule of inspections and tests.
3. Daily construction reports.
4. Material location reports.
5. Field correction reports.
6. Special reports.

B. The contractor shall submit a CPM schedule that identifies the overall project construction phasing plan as well as phasing plans for each of the project areas as identified in the document packages A, B, and C sets.

### 1.3 SUBMITTAL PROCEDURES

A. Coordination: Coordinate preparation and processing of schedules and reports with performance of other construction activities.

### 1.4 DEFINITIONS

A. Critical Path Method (CPM): A method of planning and scheduling a construction project where activities are arranged based on activity relationships and network calculations determine when activities can be performed and the critical path of the Project.

B. Critical Path: The longest continuous chain of activities through the network schedule that establishes the minimum overall project duration.

C. Network Diagram: A graphic diagram of a network schedule, showing the activities and activity relationships.

D. Activity: A discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling the construction project. Activities included in a construction schedule consume time and resources.

1. Critical activities are activities on the critical path.
2. Predecessor activity is an activity that must be completed before a given activity can be started.

E. Event: An event is the starting or ending point of an activity.

F. Milestone: A key or critical point in time for reference or measurement.

G. Float is the measure of leeway in activity performance. Accumulative float time belongs to the University.

1. Free float is the amount of time an activity can be delayed without adversely affecting the early start of the following activity.
2. Total float is the measure of leeway in starting or completing an activity without adversely affecting the planned project completion date.

1.5 QUALITY ASSURANCE

A. The Contractor's Consultant: Retain a consultant to provide planning, evaluating, and reporting by CPM scheduling.

B. The Consultant shall be a recognized specialist, acceptable to the University, who is an expert in CPM scheduling and reporting.

C. The Consultant shall have computer facilities that are capable of delivering detailed network diagrams within 48 hours of request.

D. In-House Option: The University may waive the requirement to retain a consultant if the Contractor can demonstrate that:

1. The Contractor has the computer equipment required to produce CPM network diagrams.
2. The Contractor employs skilled personnel with experience in CPM scheduling and reporting techniques.

E. Program: Use a computer software program for network analysis that has been developed specifically to manage CPM construction schedules and is acceptable to the University.

F. Standards: Comply with procedures contained in AGC's "Construction Planning & Scheduling."

1.6 RELIMINARY NETWORK DIAGRAM

A. Preliminary Network Diagram: Submit a preliminary network diagram within fourteen (14) days of the Notice to Proceed. The preliminary network diagram shall outline activities for the first sixty (60) days of construction. Include a skeleton diagram for the remainder of the Work with the preliminary diagram.

1. Include each significant construction activity. Coordinate each activity in the network with other activities. Schedule each construction activity in proper sequence.
2. Indicate completion of the Work on the date established for Substantial Completion, unless the University agrees otherwise.

B. Cash Requirement Prediction: With submittal of the preliminary network diagram, include a preliminary cash requirement prediction based on indicated activities.

C. Distribution: Distribute the preliminary network diagram to parties involved in construction activities that are scheduled early, including the University and the University.

1.7 CPM SCHEDULE

A. Prepare the Contractor's Construction Schedule using the network analysis diagram system known as the critical path method (CPM). Follow procedures outlined in AGC's "Construction Planning & Scheduling."

1. Proceed with preparation of the network diagram immediately following Notice to Proceed.
2. Follow the steps necessary to complete development of the network diagram in sufficient time to submit the CPM Schedule so it can be accepted for use no later than sixty (60) days after commencement of the Work.
3. Conduct educational workshops to train and inform key project personnel, including subcontractors' personnel, in proper methods of providing data and using CPM schedule information.
4. Establish procedures for monitoring and updating the CPM Schedule and for reporting progress. Coordinate procedures with progress meeting and payment request dates. Use "one working day" as the unit of time.

B. The CPM schedule shall adhere to the following construction phasing requirements:
1. The Howard Hall new electric room expansion, chilled water pipe relocation, Howard Hall 15kV Switchgear installation, and Howard Hall 480V Switchgear installation can begin concurrently with the North Switching Station. However, power will not be available for the Howard Hall 15kV Switchgear (and 480V switchgear) until the feeders from the North Switching Station are provided.
2. The work at the Peaking Plant can occur concurrently with the North Switching Station.
3. The MSTF generators and standby automatic transfer switches cannot be removed until the switchgear and associated control system at Howard Hall and the North Switching Station are completed and accepted as operational by the Owner. In

addition, the new 15 kV feeder spliced from manhole Ex EMH-9 shall be installed and connected to the main switchgear in MSTF prior to removal of the generators and standby automatic transfer switches.

C. CPM Schedule Preparation: Prepare a list of all activities involved in the Project. Include a list of activities required to complete the Work. No single activity shall exceed fifteen (15) work days. Provide the best data available for generation of the network diagram and the CPM Schedule.

1. Indicate the estimated time duration, sequence requirements, and relationship of each activity in relation to other activities.
2. Indicate estimated times for the following activities to be performed:
   a. Preparation and processing of submittals.
   b. Purchase of materials.
   c. Delivery.
   d. Fabrication.
   e. Installation.
3. Treat each story or separate area as a separate numbered activity for principal elements of the Work.
4. Using the preliminary network diagram, prepare a skeleton network to identify probable critical paths.

D. Processing: Enter prepared data on the processing system. Process data to produce output data or a computer-drawn, time-scaled network. Revise data, reorganize activity sequences, and reproduce as often as necessary to produce the CPM Schedule within the limitations of Contract Time.

E. Format: Display the full network on a single sheet of stable transparency, or other reproducible media, of sufficient width to show data clearly for the entire construction period.

1. Mark the critical path. Locate the critical path near the center of the network; locate paths with the most float near the edges.
2. Subnetworks on separate sheets are permissible for activities clearly off the critical path.

F. Initial Issue: Prepare the initial issue of the CPM Schedule network diagram from a listing of straight "early start-total float" sort. Identify critical activities. Prepare tabulated reports to show the following:

1. The Contractor or subcontractor and Work or activity.
2. Description of the activity.
3. Principal events of that activity.
4. Immediate preceding and succeeding activities.
5. Early and late start dates.
6. Early and late finish dates.

7. Activity duration in working days (maximum limit is fifteen (15) work days for construction activity).
8. Total float or slack time.
9. Average size of workforce.
10. Dollar value of activity (coordinated with the Schedule of Values).

G. Value Summaries: Prepare two (2) cumulative value listings, sorted by finish dates.

1. In first listing, tabulate the following:
   a. Activity number.
   b. Early finish date.
   c. Dollar value.
   d. Cumulative dollar value.
2. In second listing, tabulate the following:
   a. Activity number.
   b. Late finish date.
   c. Dollar value.
   d. Cumulative value.
3. In subsequent issues of both listings, substitute actual finish dates for activities completed as of listing date.
4. Prepare listing for ease of comparison with payment requests; coordinate timing with progress meetings.
   a. In both value summary listings, tabulate "actual percent complete," and "cumulative value completed" with total at bottom.
   b. Submit value summary printouts following each regularly scheduled progress meeting.

## 1.8 CPM SUBMITTALS

A. Submittal and Distribution: Submit three (3) copies of the initial issue of the tabulations and network to the University for acceptance. When authorized, distribute copies to the separate contractors, subcontractors and suppliers or fabricators, and others identified by the Contractor with a need-to-know schedule responsibility.

1. Post copies in the 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. Submit copies of each computer-produced report to the University.

B. Schedule Updating: Revise the schedule immediately after each meeting or other activity, where revisions have been recognized or made. Issue the updated schedule at each project meeting and submit with application for payment. Requests for payment will not be made without an updated CPM schedule.

1.9 SUBMITTAL SCHEDULE

A. After development and acceptance of the Contractor's CPM Schedule, prepare a complete schedule of submittals. Submit the schedule within ten (10) days of the date required for submittal of the Contractor's CPM Schedule.

1. Coordinate Submittal Schedule with the list of subcontracts, Schedule of Values and the list of products as well as the Contractor's Construction Schedule.

B. Prepare the schedule in chronological order. Provide the following information:

1. Scheduled date for the first submittal.
2. Related Section number.
3. Submittal category.
4. Name of the subcontractor.
5. Description of the part of the Work covered.
6. Latest scheduled date for the University's review/approval.

C. Distribution: Upon final approval of the University, print and distribute copies to the University, University, subcontractors, and other parties required to comply with submittal dates indicated.

1. Post copies in the Project meeting room and temporary field office.
2. When revisions are made, distribute to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned part of the Work and are no longer involved in construction activities.

D. Schedule Updating: Revise the schedule after each meeting or other activity where revisions have been recognized or made. Issue the updated schedule concurrently with the report of each meeting.

1.10 SCHEDULE OF INSPECTIONS AND TESTS

A. Prepare a schedule of inspections, tests, and similar services required by the Contract Documents. Submit the schedule within thirty (30) days of the date established for commencement of the Work.

B. Form: The schedule shall be in tabular form and shall include, but not be limited to, the following:

1. Specification Section number.
2. Description of the test.
3. Identification of applicable standards.
4. Identification of test methods.

5. Number of tests required.
6. Time schedule or time span for tests.
7. Entity responsible for performing tests.
8. Requirements for taking samples.
9. Unique characteristics of each service.

C. Distribution: Distribute the schedule to the University, and each party involved in performance of portions of the Work where inspections and tests are required.

D. Schedule Updating: Revise the schedule after each meeting or other activity where revisions have been recognized or made. Issue the updated schedule concurrently with the report of each meeting.

1.11 REPORTS

A. Daily Construction Reports: Prepare a daily construction report recording the following information concerning events at the site. Submit duplicate copies to the University at weekly intervals:

1. List of subcontractors at the site.
2. List of separate contractors at the site.
3. Approximate count of personnel at the site.
4. High and low temperatures, general weather conditions.
5. Accidents.
6. Meetings and significant decisions.
7. Unusual events (refer to special reports).
8. Stoppages, delays, shortages, and losses.
9. Meter readings and similar recordings.
10. Emergency procedures.
11. Orders and requests of governing authorities.
12. Change Orders received, implemented.
13. Services connected, disconnected.
14. Equipment or system tests and startups.
15. Partial Completions, occupancies.
16. Substantial Completions authorized.

B. Material Location Reports: At weekly intervals, prepare a comprehensive list of materials delivered to and stored at the site. The list shall be cumulative, showing materials previously reported plus items recently delivered. Include with the list a statement of progress on and delivery dates for materials or items of equipment fabricated or stored away from the site. Submit copies of the list to the University at weekly intervals.

1.12 SPECIAL REPORTS

A. General: Submit special reports directly to the University within one day of an occurrence. Submit a copy to other parties affected by the occurrence.

B. Reporting Unusual Events: When an event of an unusual and significant nature occurs at the site, prepare and submit a special report. List the chain of events, persons participating, response by the Contractor's personnel, an evaluation of the results or effects and similar pertinent information. Advise the University in advance when such events are anticipated or predictable.

**PART 2 - PRODUCTS** (Not Applicable)

**PART 3 - EXECUTION** (Not Applicable)

END OF SECTION 01311

# SECTION 01380 - CONSTRUCTION PHOTOGRAPHS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. This Section includes administrative and procedural requirements for construction photographs for the following types of projects:

1. New construction projects.
2. Campus renovation projects.

### 1.3 CM REQUIREMENTS

A. The CM shall make arrangements to have a series of construction photographs taken of the construction site utilizing their personnel with a digital camera.

B. The CM shall maintain an up-to-date electronic file of the photographs in numerical order per month in an XL spread sheet format as follows:

1. The XL spread sheet shall include a header with the UM Project Name and Project Number. Under the header include columns for “Photo #”, “Date” “Location on Project Site”, “View of the Photo” “Description” and “Photograph”. For Example:

a. Photo #1
b. 6-5-12
c. Roof Level
d. Looking East
e. Roof Flashing at Stair Tower
f. Photograph

### 1.4 SUBMITTALS

A. Monthly: Submit construction photographs, electronically, in “pdf” file format to the University Project Manager (PM) monthly with the application for payment.

1. Organize the electronic “pdf” files as indicated in paragraph 1.3 above.
2. Pre-construction photographs shall be submitted with the first application for payment.

1.5 PHOTOGRAPHIC REQUIREMENTS

A. The CM shall take a series of construction photographs to document conditions at the project site and during various stages of construction as follows:

1. Pre-Construction Photographs: Prior to the start of construction take photographs of the project site and adjacent areas as follows:

a. New Projects: Take photographs in sufficient number to show existing conditions adjacent to the work areas before starting work. Where applicable, take photographs of existing buildings either on or adjoining the property in sufficient detail to record accurately the physical conditions at the start of construction.

b. Campus Renovation Projects: Take photographs in sufficient number to show existing conditions adjacent to the work areas, to indicate pre construction damage to existing walls, partitions, insulation, previous work that was not completed, and/or missing materials before starting work.

2. Construction Progress Photographs:

a. Take project photographs, in accordance with requirements indicated, to best show the status of construction and progress since taking previous photographs.

b. Frequency: Take photographs weekly.

c. Vantage Points: Comply with the University's directions concerning desired vantage points for shots.

3. Record Photograph Files:

a. At the end of the project submit a complete set of record photographs, organized in XL spread sheets on a CD-R in a full size jewel case to the University. Label the CD-R and the jewel case with the UM project, UM Project Number, contents on the CD, and the submission date.

4. Post Construction Photographs:

a. After the project has completed if the A/E, the CM, and/or other contractors would like to have a series of post construction photographs taken of the project site they must submit a written request to the University PM. The PM will contact the contact the appropriate University representatives to gain approval and the set up a time for the photographs to be taken. Post

construction photographs will not be allowed without the approval of the end usurer or their representative.

END OF SECTION 01380

# SECTION 01400 - QUALITY CONTROL

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. This Section includes administrative and procedural requirements for quality-control services.

B. Quality-control services include inspections, tests, and related actions, including reports, performed by Contractor, by independent agencies, and by governing authorities. They do not include contract enforcement activities performed by the University.

C. Inspection and testing services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with Contract Document requirements.

### 1.3 RESPONSIBILITIES

A. Contractor Responsibilities: Unless otherwise indicated as the responsibility of another identified entity, Contractor shall provide inspections, tests, and other quality-control services specified elsewhere in the Contract Documents and required by authorities having jurisdiction. Costs for these services are included in the Contract Sum.

1. Where individual Sections specifically indicate that certain inspections, tests, and other quality-control services are the Contractor's responsibility, the Contractor may perform testing by its own workforce. Otherwise, and as indicated in individual Sections, the Contractor shall employ and pay a qualified independent testing agency to perform quality-control services. Costs for these services are included in the Contract Sum.
2. Where individual Sections specifically indicate that certain inspections, tests, and other quality-control services are the University's responsibility, the University will employ and pay a qualified independent testing agency to perform those services.

    a. Where the University has engaged a testing agency for testing and inspecting part of the Work, and the Contractor is also required to engage an entity for the same or related element, the Contractor shall not employ the entity engaged by the University, unless agreed to in writing by the University.

B. Retesting: The Contractor is responsible for retesting where results of inspections, tests, or other quality-control services prove unsatisfactory and indicate noncompliance with Contract

Document requirements, regardless of whether the original test was Contractor's responsibility.

1. The cost of retesting construction, revised or replaced by the Contractor, is the Contractor's responsibility where required tests performed on original construction indicated noncompliance with Contract Document requirements.

C. Associated Services: Cooperate with agencies performing required inspections, tests, and similar services, and provide reasonable auxiliary services as requested. Notify the agency sufficiently in advance of operations to permit assignment of personnel. Auxiliary services required include, but are not limited to, the following:

1. Provide access to the Work.
2. Furnish incidental labor and facilities necessary to facilitate inspections and tests.
3. Take adequate quantities of representative samples of materials that require testing or assist the agency in taking samples.
4. Provide facilities for storage and curing of test samples.
5. Deliver samples to testing laboratories.
6. Provide the agency with a preliminary design mix proposed for use for materials mixes that require control by the testing agency.
7. Provide security and protection of samples and test equipment at the Project Site.

D. Duties of the Testing Agency: The independent agency engaged to perform inspections, sampling, and testing of materials and construction specified in individual Sections shall cooperate with the University and the Contractor in performance of the agency's duties. The testing agency shall provide qualified personnel to perform required inspections and tests.

1. The agency shall notify the University and the Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
2. The agency is not authorized to release, revoke, alter, or enlarge requirements of the Contract Documents or approve or accept any portion of the Work.
3. The agency shall not perform any duties of the Contractor.

E. Coordination: Coordinate the sequence of activities to accommodate required services with a minimum of delay. Coordinate activities to avoid the necessity of removing and replacing construction to accommodate inspections and tests.

1. The Contractor is responsible for scheduling times for inspections, tests, taking samples, and similar activities.

1.4 SUBMITTALS

A. Unless the Contractor is responsible for this service, the independent testing agency shall submit a certified written report, in duplicate, of each inspection, test, or similar service to the University. If the Contractor is responsible for the service, submit a certified written report, in duplicate, of each inspection, test, or similar service through the Contractor.

1. Submit additional copies of each written report directly to the governing authority, when the authority so directs.
2. Report Data: Written reports of each inspection, test, or similar service include, but are not limited to, the following:
   a. Date of issue of report.
   b. Project title and number.
   c. Name, address, and telephone number of testing agency.
   d. Dates and locations of samples and tests or inspections.
   e. Names of individuals making the inspection or test.
   f. Designation of the Work and test method.
   g. Identification of product and Specification Section.
   h. Complete inspection or test data.
   i. Test results and an interpretation of test results.
   j. Ambient conditions at the time of sample taking and testing.
   k. Comments or professional opinion on whether inspected or tested Work complies with Contract Document requirements.
   l. Name and signature of laboratory inspector.
   m. Recommendations on retesting.

1.5 QUALITY ASSURANCE

A. Qualifications for Service Agencies: Engage inspection and testing service agencies, including independent testing laboratories, that are prequalified as complying with the American Council of Independent Laboratories' "Recommended Requirements for Independent Laboratory Qualification" and that specialize in the types of inspections and tests to be performed.

   1. Each independent inspection and testing agency engaged on the Project shall be authorized by authorities having jurisdiction to operate in the state where the Project is located.

**PART 2 - PRODUCTS** (Not Applicable)

**PART 3 - EXECUTION**

3.1 REPAIR AND PROTECTION

A. General: Upon completion of inspection, testing, sample taking and similar services, repair damaged construction and restore substrates and finishes. Comply with Contract Document requirements for Division 1 Section "Cutting and Patching."

B. Protect construction exposed by or for quality-control service activities, and protect repaired construction.

C. Repair and protection is Contractor's responsibility, regardless of the assignment of responsibility for inspection, testing, or similar services.

END OF SECTION 01400

# SECTION 01500 - CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

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

Temporary utilities include, but are not limited to, the following:

1. Water service and distribution.
2. Temporary electric power and light.
3. Temporary heat.
4. Ventilation.
5. Telephone service.
6. Sanitary facilities, including drinking water.
7. Storm and sanitary sewer.

Support facilities include, but are not limited to, the following:

1. Field offices and storage sheds.
2. Dewatering facilities and drains.
3. Temporary enclosures.
4. Hoists and temporary elevator use.
5. Temporary project identification signs and bulletin boards.
6. Waste disposal services.
7. Rodent and pest control.
8. Construction aids and miscellaneous services and facilities.

Security and protection facilities include, but are not limited to, the following:

1. Barricades, warning signs, and lights.
2. Sidewalk bridge or enclosure fence for the site.
3. Environmental protection.

### 1.3 SUBMITTALS

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

B. Implementation and Termination Schedule: Within 15 days of the date established for commencement of the Work, submit a schedule indicating implementation and termination of each temporary utility.

1.4 QUALITY ASSURANCE

A. Regulations: Comply with industry standards and applicable laws and regulations of authorities having jurisdiction including, but not limited to, the following:

1. Building code requirements.
2. Health and safety regulations.
3. Utility company regulations.
4. Police, fire department, and rescue squad rules.
5. Environmental protection regulations.

B. Standards: Comply with NFPA 241 "Standard for Safeguarding Construction, Alterations, and Demolition Operations," ANSI A10 Series standards for "Safety Requirements for Construction and Demolition," and NECA Electrical Design Library "Temporary Electrical Facilities."

1. Electrical Service: Comply with NEMA, NECA, and UL standards and regulations for temporary electric service. Install service in compliance with NFPA 70 "National Electric Code."

C. Inspections: Arrange for authorities having jurisdiction to inspect and test each temporary utility before use. Obtain required certifications and permits.

1.5 PROJECT CONDITIONS

A. Temporary Utilities: Prepare a schedule indicating dates for implementation and termination of each temporary utility. At the earliest feasible time, when acceptable to the University, change over from use of temporary service to use of permanent service.

B. Conditions of Use: Keep temporary services and facilities clean and neat in appearance. Operate in a safe and efficient manner. Relocate temporary services and facilities as the Work progresses. Do not overload facilities or permit them to interfere with progress. Take necessary fire-prevention measures. Do not allow hazardous, dangerous, or unsanitary conditions, or public nuisances to develop or persist on-site.

**PART 2 - PRODUCTS**

2.1 MATERIALS

General: Provide new materials. If acceptable to the University, the Contractor may use undamaged, previously used materials in serviceable condition. Provide materials suitable for use intended.

A. Lumber and Plywood:
   1. For signs and directory boards, provide exterior-type, Grade B-B high-density concrete form overlay plywood of sizes and thicknesses indicated.
   2. For fences and vision barriers, provide minimum 3/8-inch- (9.5-mm-) thick exterior plywood.
   3. For safety barriers, sidewalk bridges, and similar uses, provide minimum 5/8-inch- (16-mm-) thick exterior plywood.

B. Paint:
   1. For sign panels and applying graphics, provide exterior-grade alkyd gloss enamel over exterior primer.

C. Tarpaulins: Provide waterproof, fire-resistant, UL-labeled tarpaulins with flame-spread rating of fifteen (15) or less. For temporary enclosures, provide translucent, nylon-reinforced, laminated polyethylene or polyvinyl chloride, fire-retardant tarpaulins.

D. Water: Provide potable water approved by local health authorities.

E. Open-Mesh Fencing: Provide 0.120-inch- (3-mm-) thick, galvanized 2 inch (50-mm) chain link fabric fencing six (6) feet (2 m) high with galvanized barbed-wire top strand and galvanized steel pipe posts, 1-1/2 inches (38 mm) I.D. for line posts and 2-1/2 inches (64 mm) I.D. for corner posts.

2.2 EQUIPMENT

A. General: Provide new equipment. If acceptable to the University, the Contractor may use undamaged, previously used equipment in serviceable condition. Provide equipment suitable for use intended.

B. Water Hoses: Provide 3/4-inch (19-mm), heavy-duty, abrasion-resistant, flexible rubber hoses one hundred (100) feet (30 m) long, with pressure rating greater than the maximum pressure of the water distribution system. Provide adjustable shutoff nozzles at hose discharge.

C. Electrical Outlets: Provide properly configured, NEMA-polarized outlets to prevent insertion of 110- to 120-Volt plugs into higher voltage outlets. Provide receptacle outlets equipped with ground-fault circuit interrupters, reset button, and pilot light for connection of power tools and equipment.

D. Electrical Power Cords: Provide grounded extension cords. Use hard-service cords where exposed to abrasion and traffic. Provide waterproof connectors to connect separate lengths of electric cords if single lengths will not reach areas where construction activities are in progress. Do not exceed safe length-voltage ratio.

E. Lamps and Light Fixtures: Provide general service incandescent lamps of wattage required for adequate illumination. Provide guard cages or tempered-glass enclosures where exposed to breakage. Provide exterior fixtures where exposed to moisture.

F. Heating Units: Provide temporary heating units that have been tested and labeled by UL, FM, or another recognized trade association related to the type of fuel being consumed.

G. Temporary Offices: Provide prefabricated or mobile units or similar job-built construction with lockable entrances, operable windows, and serviceable finishes. Provide heated and air-conditioned units on foundations adequate for normal loading.

H. Temporary Toilet Units: Provide self-contained, single-occupant toilet units of the chemical, aerated recirculation, or combustion type. Provide units properly vented and fully enclosed with a glass-fiber-reinforced polyester shell or similar nonabsorbent material.

I. Fire Extinguishers: Provide hand-carried, portable, UL-rated, Class A fire extinguishers for temporary offices and similar spaces. In other locations, provide hand-carried, portable, UL-rated, Class ABC, dry-chemical extinguishers or a combination of extinguishers of NFPA-recommended classes for the exposures.

1. Comply with NFPA 10 and NFPA 241 for classification, extinguishing agent, and size required by location and class of fire exposure.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Use qualified personnel for installation of temporary facilities. Locate facilities where they will serve the 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 TEMPORARY UTILITY INSTALLATION

A. General: Coordinate with the University Operations and Maintenance Personnel to install temporary service or connect to existing service. Provide all necessary labor, materials and equipment for connections.

1. Coordinate with the University for a time when service can be interrupted, if necessary, to make connections for temporary services.
2. Provide adequate capacity at each stage of construction. Prior to temporary utility availability, provide trucked-in services.

3. Obtain easements to bring temporary utilities to the site where the University's easements cannot be used for that purpose.
4. Use Charges: Cost or use charges for temporary facilities are not chargeable to the University. The University will not accept cost or use charges as a basis of claims for Change Orders.

B. Water Service: Install water service and distribution piping of sizes and pressures adequate for construction until permanent water service is in use.

1. Sterilization: Sterilize temporary water piping prior to use.

C. Temporary Electric Power Service: Provide weatherproof, grounded electric power service and distribution system of sufficient size, capacity, and power characteristics during construction period. Include meters, transformers, overload-protected disconnects, automatic ground-fault interrupters, and main distribution switch gear.

1. Install electric power service underground, except where overhead service must be used.
2. Power Distribution System: Install wiring overhead and rise vertically where least exposed to damage. Where permitted, wiring circuits not exceeding 125 Volts, ac 20 Ampere rating, and lighting circuits may be nonmetallic sheathed cable where overhead and exposed for surveillance.

D. Temporary Lighting: When overhead floor or roof deck has been installed, provide temporary lighting with local switching.

1. Install and operate temporary lighting that will fulfill security and protection requirements without operating the entire system. Provide temporary lighting that will provide adequate illumination for construction operations and traffic conditions.

E. Temporary Heat: Provide temporary heat required by construction activities for curing or drying of completed installations or for protection of installed construction from adverse effects of low temperatures or high humidity. Select safe equipment that will not have a harmful effect on completed installations or elements being installed. Coordinate ventilation requirements to produce the ambient condition required and minimize consumption of energy.

F. Heating Facilities: Except where the University authorizes use of the permanent system, provide vented, self-contained, LP-gas or fuel-oil heaters with individual space thermostatic control.

1. Use of gasoline-burning space heaters, open flame, or salamander heating units is prohibited.

G. Temporary Telephones: Provide temporary telephone service throughout the construction period for all personnel engaged in construction activities. Install telephone on a separate line for each temporary office and first-aid station.

1. Separate Telephone Lines: Provide additional telephone lines for the following:
   a. Where an office has more than two (2) occupants, install a telephone for each additional occupant or pair of occupants.
   b. Provide a dedicated telephone line for a fax machine in the field office.
   c. Provide a separate line for the University's use.
2. At each telephone, post a list of important telephone numbers.

H. Sanitary facilities include temporary toilets, wash facilities, and drinking-water fixtures. Comply with regulations and health codes for the type, number, location, operation, and maintenance of fixtures and facilities. Install where facilities will best serve the Project's needs.

1. Provide toilet tissue, paper towels, paper cups, and similar disposable materials for each facility. Provide covered waste containers for used material.

I. Toilets: Install self-contained toilet units. Shield toilets to ensure privacy. Use of pit-type privies will not be permitted.

1. Provide separate facilities for male and female personnel.

J. Sewers and Drainage: Provide temporary connections to remove effluent that can be discharged lawfully. If drainage facilities cannot be lawfully used for discharge of effluent, provide containers to remove and dispose of effluent off-site in a lawful manner.

1. Filter out excessive amounts of soil, construction debris, chemicals, oils, and similar contaminants that might clog sewers or pollute waterways before discharge.
2. Connect temporary sewers to the municipal system, as directed by Baltimore City sewer department officials.
3. Maintain temporary sewers and drainage facilities in a clean, sanitary condition. Following heavy use, restore normal conditions promptly.

K. Provide earthen embankments and similar barriers in and around excavations and subgrade construction, sufficient to prevent flooding by runoff of storm water from heavy rains.

## 3.3 SUPPORT FACILITIES INSTALLATION

A. Locate field offices, storage sheds, and other temporary construction and support facilities for easy access.

1. Maintain support facilities until near Substantial Completion. Remove prior to Substantial Completion. Personnel remaining after Substantial Completion will be permitted to use permanent facilities, under conditions acceptable to the University.

B. Field Offices: Provide insulated, weather tight temporary offices of sufficient size to accommodate required office personnel at the Project Site. Keep the office clean and orderly for use for small progress meetings. Furnish and equip offices as follows:

1. Furnish with a desk and chairs, a four (4) drawer file cabinet, plan table, plan rack, and a six (6) shelf bookcase.
2. Equip with a water cooler and include a table and chairs for progress meetings, private toilet complete with water closet, lavatory, and medicine cabinet unit with a mirror.

C. Storage and Fabrication Trailers: Install storage and fabrication trailers sized, furnished, and equipped to accommodate materials and equipment involved, including temporary utility service.

D. Dewatering Facilities and Drains: For temporary drainage and dewatering facilities and operations not directly associated with construction activities included under individual Sections, comply with dewatering requirements of applicable Division 2 Sections. Where feasible, utilize the same facilities. Maintain the site, excavations, and construction free of water.

E. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities.

1. Where heat is needed and the permanent building enclosure is not complete, provide temporary enclosures where there is no other provision for containment of heat. Coordinate enclosure with ventilating and material drying or curing requirements to avoid dangerous conditions and effects.
2. Install tarpaulins securely, with incombustible wood framing and other materials. Close openings of twenty five (25) sq. ft. (2.3 sq. m) or less with plywood or similar materials.
3. Close openings through floor or roof decks and horizontal surfaces with load-bearing, wood-framed construction.

F. Project Identification and Temporary Signs: Prepare project identification and other signs of size indicated. Install signs where indicated to inform the public and persons seeking entrance to the Project. Support on posts or framing of preservative-treated wood or steel. Do not permit installation of unauthorized signs.
1. Project Identification Signs: Engage an experienced sign painter to apply graphics. Comply with details indicated.
2. Temporary Signs: Prepare signs to provide directional information to construction personnel and visitors.

G. Temporary Exterior Lighting: Install exterior yard and sign lights so signs are visible when Work is being performed.

H. Collection and Disposal of Waste: Collect waste from construction areas and elsewhere daily. Comply with requirements of NFPA 241 for removal of combustible waste material and debris. Enforce requirements strictly. Do not hold materials more than seven (7) days during normal weather or three (3) days when the temperature is expected to rise above 80°F (27°C). Handle hazardous, dangerous, or unsanitary waste materials separately from other waste by containerizing properly. Dispose of material lawfully.

I. Rodent and Pest Control: Before deep foundation work has been completed, retain a local exterminator or pest control company to recommend practices to minimize attraction and harboring of rodents, roaches, and other pests. Employ this service to perform extermination and control procedures at regular intervals so the Project will be free of pests and their residues at Substantial Completion. Perform control operations lawfully, using environmentally safe materials.

J. Stairs: Until permanent stairs are available, provide temporary stairs where ladders are not adequate. Cover finished, permanent stairs with a protective covering of plywood or similar material so finishes will be undamaged at the time of acceptance.

## 3.4 SECURITY AND PROTECTION FACILITIES INSTALLATION

A. Except for use of permanent fire protection as soon as available, do not change over from use of temporary security and protection facilities to permanent facilities until Substantial Completion, or longer, as requested by the University.

B. Temporary Fire Protection: Until fire-protection needs are supplied by permanent facilities, install and maintain temporary fire-protection facilities of the types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 10 "Standard for Portable Fire Extinguishers" and NFPA 241 "Standard for Safeguarding Construction, Alterations, and Demolition Operations."

1. Locate fire extinguishers where convenient and effective for their intended purpose, but not less than one extinguisher on each floor at or near each usable stairwell. Store combustible materials in containers in fire-safe locations.
2. Maintain unobstructed access to fire extinguishers, fire hydrants, temporary fire-protection facilities, stairways, and other access routes for fighting fires. Smoking is not permitted anywhere on project sites.
3. Provide supervision of welding operations, combustion-type temporary heating units, and similar sources of fire ignition.

C. Permanent Fire Protection: At the earliest feasible date in each area of the Project, complete installation of the permanent fire-protection facility, including connected services, and place into operation and use. Instruct key personnel on use of facilities.

D. Barricades, Warning Signs, and Lights: Comply with standards and code requirements for erection of structurally adequate barricades. Paint with appropriate colors, graphics, and warning signs to inform personnel and the public of the hazard being protected against. Where appropriate and needed, provide lighting, including flashing red or amber lights.

E. Enclosure Fence: Before excavation begins, install an enclosure fence with lockable entrance gates. Locate where indicated, or enclose the entire site or the portion determined sufficient to accommodate construction operations. Install in a manner that will prevent people, dogs, and other animals from easily entering the site, except by the entrance gates.

1. Provide open-mesh, chainlink fencing with posts set in a compacted mixture of gravel and earth.

F. Security Enclosure and Lockup: Install substantial temporary enclosure of partially completed areas of construction. Provide locking entrances to prevent unauthorized entrance, vandalism, theft, and similar violations of security.

1. Storage: Where materials and equipment must be stored, and are of value or attractive for theft, provide a secure lockup. Enforce discipline in connection with the installation and release of material to minimize the opportunity for theft and vandalism.

G. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction in ways and by methods that comply with environmental regulations, and minimize the possibility that air, waterways, and subsoil might be contaminated or polluted or that other undesirable effects might result. Avoid use of tools and equipment that produce harmful noise. Restrict use of noise-making tools and equipment to hours that will minimize complaints from persons or firms near the site.

## 3.5 OPERATION, TERMINATION, AND REMOVAL

A. Supervision: Enforce strict discipline in use of temporary facilities. Limit availability of temporary facilities to essential and intended uses to minimize waste and abuse.

B. Maintenance: Maintain facilities in good operating condition until removal. Protect from damage by freezing temperatures and similar elements.

1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a twenty four (24) hour basis where required to achieve indicated results and to avoid possibility of damage.

2. Protection: Prevent water-filled piping from freezing. Maintain markers for underground lines. Protect from damage during excavation operations.

C. Termination and Removal: Unless the University requests that it be maintained longer, remove each temporary facility when the need has ended, when 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 the 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 Contractor's property. The University reserves the right to take possession of project identification signs.
2. At Substantial Completion, clean and renovate permanent facilities used during the construction period including, but not limited to, the following:
   a. Replace air filters and clean inside of ductwork and housings.
   b. Replace significantly worn parts and parts subject to unusual operating conditions.
   c. Replace lamps burned out or noticeably dimmed by hours of use.

END OF SECTION 01500

# SECTION 01600 - MATERIALS AND EQUIPMENT, DELIVERY, STORAGE, AND HANDLING

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. This Section includes administrative and procedural requirements governing the Contractor's selection of products for use in the Project.

### 1.3 DEFINITIONS

A. Definitions used in this Article are not intended to change the meaning of other terms used in the Contract Documents, such as "specialties," "systems," "structure," "finishes," "accessories," and similar terms. Such terms are self-explanatory and have well-recognized meanings in the construction industry.

1. "Products" are items purchased for incorporation in the Work, whether purchased for the Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.
    a. "Named Products" are items identified by the manufacturer's product name, including make or model number or other designation, shown or listed in the manufacturer's published product literature, that is current as of the date of the Contract Documents.
    b. "Foreign Products," as distinguished from "domestic products," are items substantially manufactured (50 percent or more of value) outside the United States and its possessions. Products produced or supplied by entities substantially owned (more than 50 percent) by persons who are not citizens of, nor living within, the United States and its possessions are also considered to be foreign products.
2. "Materials" are products substantially shaped, cut, worked, mixed, finished, refined or otherwise fabricated, processed, or installed to form a part of the Work.
3. "Equipment" is a product with operational parts, whether motorized or manually operated, that requires service connections, such as wiring or piping.

### 1.4 SUBMITTALS:

A. All submittals shall comply with the requirements in the “SUBMITTALS” section.

### 1.5 QUALITY ASSURANCE

A. Source Limitations: To the fullest extent possible, provide products of the same kind from a single source.

   1. When specified products are available only from sources that do not, or cannot, produce a quantity adequate to complete project requirements in a timely manner, consult with the University to determine the most important product qualities before proceeding. Qualities may include attributes, such as visual appearance, strength, durability, or compatibility. When a determination has been made, select products from sources producing products that possess these qualities, to the fullest extent possible.

B. Compatibility of Options: When the Contractor is given the option of selecting between 2 or more products for use on the Project, the product selected shall be compatible with products previously selected, even if previously selected products were also options.
C. Foreign Product Limitations: Except under one or more of the following conditions, rovide domestic products, not foreign products, for inclusion in the Work:

   1. No available domestic product complies with the Contract Documents.
   2. Domestic products that comply with the Contract Documents are available only at prices or terms substantially higher than foreign products that comply with the Contract Documents.

D. Nameplates: Except for required labels and operating data, do not attach or imprint manufacturer's or producer's nameplates or trademarks on exposed surfaces of products that will be exposed to view in occupied spaces or on the exterior.

   1. Labels: Locate required product labels and stamps on concealed surfaces or, where required for observation after installation, on accessible surfaces that are not conspicuous.
   2. Equipment Nameplates: Provide a permanent nameplate on each item of service-connected or power-operated equipment. Locate on an easily accessible surface that is inconspicuous in occupied spaces. The nameplate shall contain the following information and other essential operating data:
      a. Name of product and manufacturer.
      b. Model and serial number.
      c. Capacity.
      d. Speed.
      e. Ratings.

## 1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle products according to the manufacturer's recommendations, using means and methods that will prevent damage, deterioration, and loss, including theft.

1. Schedule delivery to minimize long-term storage at the site and to prevent overcrowding of construction spaces.
2. Coordinate delivery with installation time to assure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
3. Deliver products to the site in an undamaged condition in the manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
4. Inspect products upon delivery to ensure compliance with the Contract Documents and to ensure that products are undamaged and properly protected.
5. Store products at the site in a manner that will facilitate inspection and measurement of quantity or counting of units.
6. Store heavy materials away from the Project structure in a manner that will not endanger the supporting construction.
7. Store products subject to damage by the elements above ground, under cover in a weather tight enclosure, with ventilation adequate to prevent condensation. Maintain temperature and humidity within range required by manufacturer's instructions.

## PART 2 - PRODUCTS

### 2.1 PRODUCT SELECTION

A. General Product Requirements: Provide products that comply with Contract Documents that are undamaged and new at time of installation.

1. Provide products complete with accessories, trim, finish, safety guards, and other devices and details needed for complete installation and intended use and effect.
2. Standard Products: Where available, provide standard products of types that have been produced and used successfully in similar situations on other projects.
3. Where products are accompanied by the term as selected, University will make selection.
4. Where products are accompanied by the term match sample, sample to be matched is University's.
5. Descriptive, performance, and reference standard requirements in the Specifications establish salient characteristics of products.

A. General Compliance Requirements: Compliance requirements for individual products, as indicated in Contract Documents, are multiple in nature and may include generic descriptions, performance requirements, compliance with reference standards, conformance with graphic details and other similar forms and methods of indicating requirements, all of which must be complied with.

B. Procedures for Selecting Products: Contractor's options for selecting products are limited by Contract Document requirements, and are not controlled by industry traditions or procedures experienced by Contractor on previous construction projects.

C. Products specified by Reference Standards, Codes and Regulations: Select from among products which can be shown to comply to referenced documents.

D. Products specified by Naming Products and Manufacturers: Select from among products listed.

E. Products specified by Naming One Manufacturer's Product as the Basis-of-Design with Reference to Other Manufacturers: Select either the specified Basis-of-Design product or an approved comparable product by one of the other named manufacturers.

1. Comply with provisions in Comparable Products Article to obtain approval for use of a comparable product by one of the named manufacturers.

F. Products specified by Naming One Manufacturer's Product and Indicating Option of Selecting Comparable Products by stating or Approved Equivalent or similar language: Select either the specified product or an approved comparable product.

1. Comply with provisions in Comparable Products Article to obtain approval for use of an unnamed comparable product by another manufacturer.

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

H. Visual Selection Specification: Where Specifications include the phrase as selected from manufacturer's standard colors, patterns, textures or similar phrase, select a product that complies with other specified requirements. University will select color, pattern, and texture.

1. Standard Range: Where Specifications include the phrase standard range of colors, patterns, textures or similar phrase, University will select color, pattern, or texture from manufacturer's product line that does not include premium items.
2. Full Range: Where Specifications include the phrase full range of colors, patterns, textures or similar phrase, University will select color, pattern, or texture from manufacturer's product line that includes both standard and premium items.

## 2.2 COMPARABLE PRODUCTS

A. Where Basis-of-Design products are specified by name, submit the following, in addition to other required submittals, to obtain approval of a comparable product by one of the named manufacturers:

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 the Basis-of-Design product in the Specifications. Significant qualities include attributes such as performance, weight, size, durability, serviceability, 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 Universities, if requested.
5. Samples, if requested.

## PART 3 - EXECUTION

### 3.1 INSTALLATION OF PRODUCTS

A. Comply with manufacturer's instructions and recommendations for installation of products in the applications indicated. Anchor each product securely in place, accurately located and aligned with other Work.

1. Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.

B. Install products in accordance with the execution’s sections of the Project Manual.

END OF SECTION 01600

# SECTION 01631 - SUBSTITUTIONS

## PART 1 – GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. This Section includes administrative and procedural requirements for handling requests for substitutions made after award of the Contract.

B. Contractor's submittal and University's acceptance of Shop Drawings, Product Data, or Samples not complying with Contract Documents do not constitute an acceptable or valid request for substitution, nor do they constitute approval. Substitutions not properly authorized may be considered defective.

### 1.3 DEFINITIONS

A. Definitions in this Article do not change or modify the meaning of other terms used in the Contract Documents.

B. Substitutions: Changes in products, materials, equipment, and methods of construction required by the Contract Documents proposed by the Contractor after award of the Contract are considered to be requests for substitutions. The following are not considered to be requests for substitutions:

1. Substitutions requested during the bidding period, and accepted by Addendum prior to award of the Contract, are included in the Contract Documents and are not subject to requirements specified in this Section for substitutions.
2. Revisions to the Contract Documents requested by the University or University.
3. Specified options of products and construction methods included in the Contract Documents.
4. The Contractor's determination of and compliance with governing regulations and orders issued by governing authorities.

### 1.4 SUBMITTALS

A. Substitution Request Submittal: The University will consider requests for substitution if received within sixty (60) days after issuance of Notice to Proceed. Requests received more than sixty (60) days after issuance of Notice to Proceed may be considered or rejected at the discretion of the University.

1. Submit three (3) copies of each request for substitution for consideration. Submit requests in the form and according to procedures required for change-order proposals.
2. Identify the product or the fabrication or installation method to be replaced in each request. Include related Specification Section and Drawing numbers.
3. Provide complete documentation showing compliance with the requirements for substitutions, and the following information, as appropriate:
    a. Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by the University and separate contractors, that will be necessary to accommodate the proposed substitution.
    b. A detailed comparison of significant qualities of the proposed substitution with those of the Work specified. Significant qualities may include elements, such as performance, weight, size, durability, and visual effect.
    c. Product Data, including Drawings and descriptions of products and fabrication and installation procedures.
    d. Samples, where applicable or requested.
    e. A statement indicating the substitution's effect on the Contractor's CPM Construction Schedule compared to the schedule without approval of the substitution. Indicate the effect of the proposed substitution on overall Contract Time.
    f. Cost information, including a proposal of the net change, if any in the Contract Sum.
    g. The Contractor's certification that the proposed substitution has been fully investigated and determined to be equal or superior in all respects to specified product.
    h. The Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of the failure of the substitution to perform adequately.
    i. Confirmation that the same warranty will be furnished for substitute product as for specified product.

1.5 UNIVERSITY'S ACTION

A. University will review and take appropriate action upon Contractor's request for substitutions.

1. University's action will be taken with reasonable promptness, while allowing sufficient time in University's professional judgement to permit adequate review.
2. University shall be entitled to rely upon adequacy, accuracy, and completeness of data, and certifications prepared by Contractor.
3. If necessary, University will request additional information or documentation for evaluation after initial review of receipt of request for substitution.

**PART 2 – PRODUCTS** (Not Used)

**PART 3 - EXECUTION** (Not Used)

END OF SECTION 01631

# SECTION 01700 - CONTRACT CLOSEOUT

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. This Section includes administrative and procedural requirements for contract closeout including, but not limited to, the following:

1. Inspection procedures.
2. Project record document submittal, including the following:
3. Marked-up copies of Contract Drawings.
4. Marked-up copies of Shop Drawings.
5. Newly prepared drawings.
6. Marked-up copies of Specifications, addenda, and Change Orders.
7. Marked-up Product Data submittals.
8. Record Samples.
9. Field records for variable and concealed conditions.
10. Record information on Work that is recorded only schematically.
11. Operation and maintenance manual submittal.
12. Preparing and submitting operation and maintenance manuals for building operating systems and equipment.
13. Preparing and submitting instruction manuals covering the care, preservation, and maintenance of University products and finishes.
14. Instruction of the University's operating personnel in the operation and maintenance of building systems and equipment.
15. Submittal of warranties.
16. Final cleaning.

B. Closeout requirements for specific construction activities are included in the appropriate Sections the specifications.

C. Environmental Requirements: Conduct cleaning and waste-disposal operations in compliance with local laws and ordinances. Comply fully with federal and local environmental and antipollution regulations.

1. Do not dispose of volatile wastes, such as mineral spirits, oil, or paint thinner, in storm or sanitary drains.
2. Burning or burying of debris, rubbish, or other waste material on the premises is not permitted.

D. Maintenance of 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. Make documents and Samples available at all times for the University's inspections.

E. Disclaimers and Limitations: Manufacturer's disclaimers and limitations on product warranties do not relieve the Contractor of the warranty on the Work that incorporates the products. Manufacturer's disclaimers and limitations on product warranties do not relieve suppliers, manufacturers, and subcontractors required to countersign special warranties with the Contractor.

1.3 DEFINITIONS

A. Standard product warranties are preprinted written warranties published by individual manufacturers for particular products and are specifically endorsed by the manufacturer to the University.

B. Special warranties are written warranties required by or incorporated in the Contract Documents, either to extend time limits provided by standard warranties or to provide greater rights for the University.

1.4 WARRANTY REQUIREMENTS

A. Related Damages and Losses: When correcting failed or damaged warranted construction, remove and replace construction that has been damaged as a result of such failure or must be removed and replaced to provide access for correction of warranted construction.

B. Reinstatement of Warranty: When Work covered by a warranty has failed and been corrected by replacement or rebuilding, reinstate the warranty by written endorsement. The reinstated warranty shall be equal to the original warranty with an equitable adjustment for depreciation.

C. Replacement Cost: Upon determination that Work covered by a warranty has failed, replace or rebuild the Work to an acceptable condition complying with requirements of the Contract Documents. The Contractor is responsible for the cost of replacing or rebuilding defective Work regardless of whether the University has benefited from use of the Work through a portion of its anticipated useful service life.

D. University's Recourse: Expressed warranties made to the University are in addition to implied warranties and shall not limit the duties, obligations, rights, and remedies otherwise available under the law. Expressed warranty periods shall not be interpreted as limitations on the time in which the University can enforce such other duties, obligations, rights, or remedies.

1. Rejection of Warranties: The University reserves the right to reject warranties and to limit selection to products with warranties not in conflict with requirements of the Contract Documents.

E. Where the Contract Documents require a special warranty, or similar commitment on the Work or part of the Work, the University reserves the right to refuse to accept the Work, until the Contractor presents evidence that entities required to countersign such commitments are willing to do so.

1.5 SUBSTANTIAL COMPLETION

A. Preliminary Procedures: Before requesting inspection for certification of Substantial Completion, complete the following. List exceptions in the request.

1. In the Application for Payment that coincides with, or first follows, the date Substantial Completion is claimed, show 100 percent completion for the portion of the Work claimed as substantially complete.
   a. Include supporting documentation for completion as indicated in these Contract Documents and a statement showing an accounting of changes to the Contract Sum.
   b. If 100 percent completion cannot be shown, include a list of incomplete items, the value of incomplete construction, and reasons the Work is not complete.
2. Advise the University of pending insurance changeover requirements.
3. Submit specific warranties, workmanship bonds, maintenance agreements, final certifications, and similar documents.
4. Obtain and submit releases enabling the University unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
5. Submit record drawings, maintenance manuals, final project photographs, damage or settlement surveys, property surveys, and similar final record information.
6. Deliver tools, spare parts, extra stock, and similar items, including inventory list.
7. Make final changeover of permanent locks and transmit keys to the University. Advise the University's personnel of changeover in security provisions.
8. Complete startup testing of systems and instruction of the University's operation and maintenance personnel. Discontinue and remove temporary facilities from the site, along with mockups, construction tools, and similar elements.
9. Complete final cleanup requirements, including touchup painting.
10. Touch up and otherwise repair and restore marred, exposed finishes.

B. Inspection Procedures: On receipt of a request for inspection, the University will either proceed with inspection or advise the Contractor of unfilled requirements. The University will prepare the Certificate of Substantial Completion following inspection or advise the Contractor of construction that must be completed or corrected before the certificate will be issued.

1. The University will repeat inspection when requested and assured that the Work is substantially complete.

2. Results of the completed inspection will form the basis of requirements for final acceptance.

1.6 FINAL ACCEPTANCE

A. Preliminary Procedures: Before requesting final inspection for certification of final acceptance and final payment, complete the following. List exceptions in the request.

1. Submit the final payment request with releases and supporting documentation not previously submitted and accepted. Include insurance certificates for products and completed operations where required.
2. Submit an updated final statement, accounting for final additional changes to the Contract Sum.
3. Submit a certified copy of the University's final punch list of items to be completed or corrected, endorsed and dated by the University. The certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance and will be endorsed and dated by the University.
4. Submit final meter readings for utilities, a measured record of stored fuel, and similar data as of the date of Substantial Completion or when the University took possession of and assumed responsibility for corresponding elements of the Work.
5. Submit consent of surety to final payment.
6. Submit a final liquidated damages settlement statement.
7. Submit evidence of final, continuing insurance coverage complying with insurance requirements.

B. Reinspection Procedure: The University will reinspect the Work upon receipt of notice that the Work, including inspection list items from earlier inspections, has been completed, except for items whose completion is delayed under circumstances acceptable to the University.

1. Upon completion of reinspection, the University will prepare a certificate of final acceptance. If the Work is incomplete, the University will advise the Contractor of Work that is incomplete or of obligations that have not been fulfilled but are required for final acceptance.

2. If necessary, reinspection will be repeated.

1.7 QUALITY ASSURANCE

A. Maintenance Manual Preparation: In preparation of maintenance manuals, use personnel thoroughly trained and experienced in operation and maintenance of equipment or system involved.

1. Where maintenance manuals require written instructions, use personnel skilled in technical writing where necessary for communication of essential data.
2. Where maintenance manuals require drawings or diagrams, use draftsmen capable of preparing drawings clearly in an understandable format.

B. Instructions for the University's Personnel: Use experienced instructors thoroughly trained and experienced in operation and maintenance of equipment or system involved to instruct the University's operation and maintenance personnel.

1.8 RECORD DOCUMENT SUBMITTALS

A. General: Do not use record documents for construction purposes. Protect record documents from deterioration and loss in a secure, fire-resistant location. Provide access to record documents for the University's reference during normal working hours.

B. Record Drawings (As-Builts):

1. Markup Procedure: During construction, maintain a set of blue- or black-line white prints of Contract Drawings and Shop Drawings for Project Record Document (As-Built) purposes.
   a. Mark these Drawings to show the actual installation where the installation varies from the installation shown originally. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later. Items required to be marked include, but are not limited to, the following:
      1) Dimensional changes to the Drawings.
      2) Revisions to details shown on the Drawings.
      3) Depths of foundations below the first floor.
      4) Locations and depths of underground utilities.
      5) Revisions to routing of piping and conduits.
      6) Revisions to electrical circuitry.
      7) Actual equipment locations.
      8) Duct size and routing.
      9) Locations of concealed internal utilities.
      10) Changes made by change order.
      11) Changes made following the University's written orders.
      12) Details not on original Contract Drawings.
   b. Mark record prints of Contract Drawings or Shop Drawings, whichever is most capable of showing actual physical conditions, completely and accurately. Where Shop Drawings are marked, show cross-reference on Contract Drawings location.

c. Mark record sets with red erasable colored pencil. Use other colors to distinguish between changes for different categories of the Work at the same location.
d. Mark important additional information that was either shown schematically or omitted from original Drawings.
e. Note change-order numbers, and similar identification.

2. Responsibility for Markup: The individual or entity who obtained record data, whether the individual or entity is the Installer, subcontractor, or similar entity, shall prepare the markup on record drawings.
a. Accurately record information in an understandable drawing technique.
b. Record data as soon as possible after obtaining it. Record and check the markup prior to enclosing concealed installations.
c. At time of Substantial Completion, submit record drawings to the University for the University's records. Organize into sets and bind and label sets for the University's continued use.

C. Record Specifications

1. During the construction period, maintain one copy of the Project Specifications, including addenda and modifications issued, for Project Record Document purposes.
a. Mark the Specifications to indicate the actual installation where the installation varies from that indicated in Specifications and modifications issued. Note related project record drawing information, where applicable. Give particular attention to substitutions, selection of product options, and information on concealed installations that would be difficult to identify or measure and record later.
1) In each Specification Section where products, materials, or units of equipment are specified or scheduled, mark the copy with the proprietary name and model number of the product furnished.
2) Record the name of the manufacturer, supplier, installer, and other information necessary to provide a record of selections made and to document coordination with record Product Data submittals and maintenance manuals.
3) Note related record Product Data, where applicable. For each principal product specified, indicate whether record Product Data has been submitted in maintenance manual instead of submitted as record Product Data.
b. Upon completion of markup, submit record Specifications to the University.

D. Record Product Data: Maintain one copy of each Product Data submittal. Note related Change Orders and markup of record drawings and Specifications.

1. Mark these documents to show significant variations in actual Work performed in comparison with information submitted. Include variations in products delivered to the site and from the manufacturer's installation instructions and recommendations.

2. Give particular attention to concealed products and portions of the Work that cannot otherwise be readily discerned later by direct observation.
3. Upon completion of markup, submit three complete sets of record Product Data to the University for the University's records.

E. Record Sample Submitted: Immediately prior to Substantial Completion, the Contractor shall meet with the University and the University's personnel at the Project Site to determine which Samples are to be transmitted to the University for record purposes. Comply with the University's instructions regarding delivery to the University's Sample storage area. Dispose of other samples in a manner specified for disposing surplus and waste materials.

F. Miscellaneous Record Submittals:

1. Refer to other Specification Sections for miscellaneous record-keeping requirements and submittals in connection with various construction activities. Immediately prior to Substantial Completion, complete miscellaneous records and place in good order, properly identified and bound or filed, ready for use and reference. Submit to the University for the University's records.
   a. Categories of requirements resulting in miscellaneous records include, but are not limited to, the following:
      1) Field records on excavations and foundations.
      2) Field records on underground construction and similar work.
      3) Survey showing locations and elevations of underground lines.
      4) Invert elevations of drainage piping.
      5) Surveys establishing building lines and levels.
      6) Records of plant treatment.
      7) Ambient and substrate condition tests.
      8) Certifications received in lieu of labels on bulk products.
      9) Batch mixing and bulk delivery records.
      10) Testing and qualification of tradesmen.
      11) Documented qualification of installation firms.
      12) Load and performance testing.
      13) Inspections and certifications by governing authorities.
      14) Leakage and water-penetration tests.
      15) Fire-resistance and flame-spread test results.
      16) Final inspection and correction procedures.
      17) Pipe leakage test reports.
      18) Duct leakage test reports.
      19) Air and water balance reports.

G. Operation and Maintenance Manuals:

1. General Submission Requirements: The University of Maryland (UM) requires operation and maintenance manuals (O&MM) to be submitted in electronic “pdf” file

format, by the CM, before substantial completion to the A/E and the University for review.

2. Product Data: All product data and shop drawing "pdf" files submitted during the shop drawing review phase must be complete per the requirements of the bid documents. These files can be either scanned as a "pdf" file or the files can be converted to "pdf" format provided the "pdf" files are clear and readable when either viewed on a computer monitor or printed on 8.5 x 11 or 11 x 17 paper. UM has examples of prints from electronic submittal files that are either acceptable or unacceptable and are available upon request. Contact the University project manager for file examples, if necessary.

3. General File Description: The following description outlines the organization of one (1) electronic O&MM file for each discipline such as, Architectural, Structural, Civil, Mechanical, and Electrical including the minimum documentation that shall be included in each O&MM file for each discipline. Each File shall be arranged as a stack file with bookmarks and a tree structure.

4. Arrangement: Arrange each O&MM file in a similar manner as a hard bound copy would be set up and submitted. For each discipline O&MM file include:

    a. Cover: Include the University Project Title, University Project Number, and Date.

    b. Table of Contents: Numeric List of each page with page 1 being the Cover Sheet, then each product submittal and shop drawing.

    c. Subcontractor List: List each subcontractor by company name, address, contact name and phone number for each approved product data submittal and/or approved shop drawing included in the file.

    d. Supplier List: List each manufacturer's company name, address, contact name and phone number for each approved product data submittal and/or approved shop drawing included in the file.

    e. Contractor Warranty Statement: Warranty statement in letter for the project warranty on the letter head of the mechanical contractor.

    f. Maintenance Chart: Include a maintenance chart for each piece of equipment or type of material that requires periodic maintenance. List the equipment and parts requiring the maintenance and the time interval.

    g. Warranty and Instruction Information: Include any warranty information and/or manufacturers operating and maintenance instructions including replacement part's list with each product. Each product data submittal, shop

drawing, warranty data, instructions shall be an individual "pdf" file for said data. Include Approved submittal data only.

5. General File Structure Example: Each discipline file structure shall be arranged using the structure example as follows:

   a. Table of Contents: Include the following:
      1) Cover Sheet
      2) Subcontractors List
      3) Suppliers List
      4) Contractor Warranty
      5) Maintenance Charts
      6) Discipline Specific Main Folders and Subfolders Content

6. Discipline O&MM Files: Each discipline O&MM files shall be arranged as follows:
   a. Architectural O&MM file include:
      1) Exterior: Include all submittals related to the Exterior.
      2) Interior: Include all submittals related to the Interior.
      3) Furnishings: Include all submittals related to the Furnishings.
      4) Equipment: Include all submittals related to the Equipment.
      5) Signage: Include all submittals related to the Signage.

   b. Structural O&MM file includes:
      1) Include all submittals related to Structural

   c. Civil O&MM file includes:
      1) Include all submittals related to Civil

   d. Mechanical O&MM file includes:
      1) Plumbing: Include all submittals related to Plumbing.
      2) HVAC: Include all submittals related to HVAC.
      3) Fire Protection: Include all submittals related to Fire Protection plus the complete fire protection drawings in "dwg" file format on a CD.

   e. Electrical O&MM file includes:
      1) Lighting: Include all submittals related to Lighting
      2) Power: Include all submittals related to Power
      3) Fire Alarm: Include all submittals related to the Fire Alarm System plus the complete fire alarm drawings in "dwg" file format on a

4) Security: Include all submittals related to Security plus the complete security drawings in "dwg" file format on a CD.
5) Telecomm: Include all submittals related to telecomm plus the complete telecomm drawings in "dwg" file format on a CD.
6) Audio/visual: Include all submittals related to A/V plus the complete A/V drawings in "dwg" file format on a CD.

7. Discipline System File Name and "pdf" Tree Structure: Each Discipline System fie name and "pdf" tree structure including main folders and sub folders shall be arranged as follows:
   a. File Name: Architectural O&MM
      1) "PDF" Tree Structure – Main Folders
      a) Π Cover Sheet
      b) Π Table of Contents
      c) Π Subcontractor List
      d) Π Suppliers List
      e) Π Contractor Warranty
      f) Π Maintenance Charts
      g) Π Exterior
      h) Π Interior
      i) Π Furnishings
      j) Π Equipment
      k) Π Signage

   b. "PDF" Tree Structure – Main Topic - Sub Folders Example
      a) Π Furnishings
         (1) Π Laboratory Case Work
            (a) Π Approved Product Submittal File Product Data
            (b) Π Case Work Drawings
            (c) Π Manufacturers Warranty
            (d) Π Repeat Above sub folders for each approved product submittal

   c. File Name: Mechanical O&MM
      1) "PDF" Tree Structure – Main Folders
         a) Π Cover Sheet
         b) Π Table of Contents
         c) Π Subcontractor List
         d) Π Suppliers List
         e) Π Contractor Warranty
         f) Π Maintenance Charts
         g) Π Plumbing
         h) Π HVAC

i) Π Fire Protection

2) "PDF" Tree Structure – Main Topic - Sub Folders Example
a) Π Plumbing
(1) Π Domestic Water Booster Pump
(a) Π Approved Product Submittal File
(b) Π Manufacturers Maintenance Data
(c) Π Manufacturers Warranty
b) Π Repeat Above sub folders for each approved product submittal

d. File Name: Electrical O&MM
1) "PDF" Tree Structure – Main Folders
a) Π Cover Sheet
b) Π Table of Contents
c) Π Subcontractor List
d) Π Suppliers List
e) Π Contractor Warranty
f) Π Maintenance Charts
g) Π Lighting
h) Π Power
i) Π Security
j) Π Fire Alarm
k) Π Telecomm
l) Π Audio Visual

2) "PDF" Tree Structure – Main Topic - Sub Folders Example
a) Π Lighting
(1) Π 2x4 Light Fixtures
(2) Π Approved Product Submittal File Product Data
(3) Π Manufacturers Maintenance Data
(4) Π Manufacturers Warranty
b) Π Repeat Above sub folders for each approved product submittal

## 1.9 INSTRUCTIONS FOR THE UNIVERSITY'S PERSONNEL

A. Prior to final inspection, instruct the University's personnel in operation, adjustment, and maintenance of products, equipment, and systems. Provide instruction at mutually agreed upon times.

1. For equipment that requires seasonal operation, provide similar instruction during other seasons.

2. Use operation and maintenance manuals for each piece of equipment or system as the basis of instruction. Review contents in detail to explain all aspects of operation and maintenance.

2.1 MATERIALS

A. Cleaning Agents: Use cleaning materials and agents recommended by the 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 2 - EXECUTION**

3.1 CLOSEOUT PROCEDURES

A. Operation and Maintenance Instructions: Arrange for each Installer of equipment that requires regular maintenance to meet with the University's personnel to provide instruction in proper operation and maintenance. Provide instruction by manufacturer's representatives if installers are not experienced in operation and maintenance procedures. Include a detailed review of the following items:
   1. Maintenance manuals.
   2. Record documents.
   3. Spare parts and materials.
   4. Tools.
   5. Lubricants.
   6. Fuels.
   7. Identification systems.
   8. Control sequences.
   9. Hazards.
   10. Cleaning.
   11. Warranties and bonds.
   12. Maintenance agreements and similar continuing commitments.

B. As part of instruction for operating equipment, demonstrate the following procedures:
   1. Startup.
   2. Shutdown.
   3. Emergency operations.
   4. Noise and vibration adjustments.
   5. Safety procedures.
   6. Economy and efficiency adjustments.
   7. Effective energy utilization.

3.2 FINAL CLEANING

A. General: The General Conditions require general cleaning during construction. Regular site cleaning is included in Division 1 Section "Construction Facilities and Temporary Controls."

B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to the condition expected in a normal, commercial building cleaning and maintenance program. Comply with manufacturer's instructions.

1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion.
   a. Clean the Project Site, yard and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and foreign substances.
   b. Sweep paved areas broom clean. Rake grounds that are neither planted nor paved to a smooth, even-textured surface.
   c. Remove petrochemical spills, stains, and other foreign deposits.
   d. Remove tools, construction equipment, machinery, and surplus material from the site.
   e. Remove snow and ice to provide safe access to the building.
   f. 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.
   g. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
   h. Broom clean concrete floors in unoccupied spaces.
   i. Vacuum clean carpet and similar soft surfaces, removing debris and excess nap. Shampoo, if required.
   j. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other substances that are noticeable vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials. Polish mirrors and glass, taking care not to scratch surfaces.
   k. Remove labels that are not permanent labels.
   l. 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.
   m. Wipe surfaces of mechanical and electrical equipment, elevator equipment, and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
   n. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
   o. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
   p. Clean ducts, blowers, and coils if units were operated without filters during construction.

q. Clean food-service equipment to a sanitary condition, ready and acceptable for its intended use.
r. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency. Replace burned-out bulbs and defective and noisy starters in fluorescent and mercury vapor fixtures.
s. Leave the Project clean and ready for occupancy.

C. Removal of Protection: Remove temporary protection and facilities installed for protection of the Work during construction.

D. Compliance: Comply with regulations of authorities having jurisdiction and safety standards for cleaning. Do not burn waste materials. Do not bury debris or excess materials on the University's property. Do not discharge volatile, harmful, or dangerous materials into drainage systems. Remove waste materials from the site and dispose of lawfully.

1. Where extra materials of value remain after completion of associated Work, they become the University's property. Dispose of these materials as directed by the University.

END OF SECTION 01700

# SECTION 015639 - TEMPORARY TREE AND PLANT PROTECTION

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section includes general protection and pruning of existing trees and plants that are affected by execution of the Work, whether temporary or permanent construction.

B. Related Requirements:

1. Section 015000 "Temporary Facilities and Controls" for temporary site fencing.
2. Section 311000 "Site Clearing" for removing existing trees and shrubs.

### 1.3 DEFINITIONS

A. Caliper: Diameter of a trunk measured by a diameter tape at a height 6 inches above the ground for trees up to and including 4-inch size at this height and as measured at a height of 12 inches above the ground for trees larger than 4-inch size.

B. Caliper (DBH): Diameter breast height; diameter of a trunk as measured by a diameter tape at a height 54 inches above the ground line for trees with caliper of 8 inches or greater as measured at a height of 12 inches above the ground.

C. Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction and indicated on Drawings.

D. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction and defined by a circle concentric with each tree with a radius 12 times the tree's caliper size and with a minimum radius of 96 inches unless otherwise indicated.

E. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

### 1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Include plans, elevations, sections, and locations of protection-zone fencing and signage, showing relation of equipment-movement routes and material storage locations with protection zones.
2. Detail fabrication and assembly of protection-zone fencing and signage.
3. Indicate extent of trenching by hand or with air-spade within protection zones.

## 1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For arborist and tree service firm.

B. Certification: From arborist, certifying that trees indicated to remain have been protected during construction according to recognized standards and that trees were promptly and properly treated and repaired when damaged.

C. Maintenance Recommendations: From arborist, for care and protection of trees affected by construction during and after completing the Work.

D. Existing Conditions: Documentation of existing trees and plantings indicated to remain, which establishes preconstruction conditions that might be misconstrued as damage caused by construction activities.

1. Use sufficiently detailed photographs or video recordings.
2. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plants designated to remain.

E. Quality-control program.

## 1.6 QUALITY ASSURANCE

A. Arborist Qualifications: Certified Arborist as certified by ISA.

B. Tree Service Firm Qualifications: An experienced tree service firm that has successfully completed temporary tree and plant protection work similar to that required for this Project and that will assign an experienced, qualified arborist to Project site during execution of the Work.

C. Quality-Control Program: Prepare a written program to systematically demonstrate the ability of personnel to properly follow procedures and handle materials and equipment during the Work without damaging trees and plantings. Include dimensioned diagrams for placement of protection zone fencing and signage, the arborist's and tree-service firm's responsibilities, instructions given to workers on the use and care of protection zones, and enforcement of requirements for protection zones.

1.7 FIELD CONDITIONS

A. The following practices are prohibited within protection zones:

1. Storage of construction materials, debris, or excavated material.
2. Moving or parking vehicles or equipment.
3. Foot traffic.
4. Erection of sheds or structures.
5. Impoundment of water.
6. Excavation or other digging unless otherwise indicated.
7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

B. Do not direct vehicle or equipment exhaust toward protection zones.

C. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones and organic mulch.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Protection-Zone Fencing: Fencing fixed in position and meeting the following requirements:

1. Plastic Protection-Zone Fencing: Plastic construction fencing constructed of high-density extruded and stretched polyethylene fabric with 2-inch maximum opening in pattern and weighing a minimum of 0.4 lb/ft.; remaining flexible from minus 60 to plus 200°F; inert to most chemicals and acids; minimum tensile yield strength of 2000 psi and ultimate tensile strength of 2680 psi; secured with plastic bands or galvanized-steel or stainless-steel wire ties; and supported by tubular or T-shape galvanized-steel posts spaced not more than 96 inches apart.

a. Height: 48 inches.
b. Color: High-visibility orange, nonfading.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Erosion and Sedimentation Control: Examine the site to verify that temporary erosion- and sedimentation-control measures are in place. Verify that flows of water redirected

from construction areas or generated by construction activity do not enter or cross protection zones.

B. Prepare written report, endorsed by arborist, listing conditions detrimental to tree and plant protection.

## 3.2 PREPARATION

A. Locate and clearly identify trees, shrubs, and other vegetation to remain. Tie a 1-inch blue vinyl tape around each tree trunk at 54 inches above the ground.

B. Protect tree root systems from damage caused by runoff or spillage of noxious materials while mixing, placing, or storing construction materials. Protect root systems from ponding, eroding, or excessive wetting caused by dewatering operations.

C. Tree-Protection Zones: Mulch areas inside tree-protection zones and other areas indicated. Do not exceed indicated thickness of mulch.

1. Apply 2-inch uniform thickness of organic mulch unless otherwise indicated. Do not place mulch within 6 inches of tree trunks.

## 3.3 PROTECTION ZONES

A. Protection-Zone Fencing: Install protection-zone fencing along edges of protection zones before materials or equipment are brought on the site and construction operations begin in a manner that will prevent people from easily entering protected areas except by entrance gates. Construct fencing so as not to obstruct safe passage or visibility at vehicle intersections where fencing is located adjacent to pedestrian walkways or in close proximity to street intersections, drives, or other vehicular circulation.

1. Posts: Set or drive posts into ground one-third the total height of the fence (minimum 24” depth) without concrete footings. Where a post is located on existing paving or concrete to remain, provide appropriate means of post support acceptable to Engineer.

B. Protection-Zone Signage: Install protection-zone signage in visibly prominent locations in a manner approved by Engineer. Install one sign spaced approximately every 20 feet on protection-zone fencing, but no fewer than four signs with each facing a different direction.

C. Maintain protection zones free of weeds and trash.

D. Maintain protection-zone fencing and signage in good condition as acceptable to Engineer and remove when construction operations are complete and equipment has been removed from the site.

1. Do not remove protection-zone fencing, even temporarily, to allow deliveries or equipment access through the protection zone.
2. Temporary access is permitted subject to preapproval in writing by arborist if a root buffer effective against soil compaction is constructed as directed by arborist. Maintain root buffer so long as access is permitted.

## 3.4 EXCAVATION

A. General: Excavate at edge of protection zones and for trenches indicated within protection zones according to requirements in Section 312000 "Earth Moving" unless otherwise indicated.

B. Do not allow exposed roots to dry out before placing permanent backfill. Provide temporary earth cover or pack with peat moss and wrap with burlap. Water and maintain in a moist condition. Temporarily support and protect roots from damage until they are permanently relocated and covered with soil.

## 3.5 ROOT PRUNING

A. Prune tree roots that are affected by temporary and permanent construction. Prune roots as shown on Drawings and as follows:

1. Cut roots manually by digging a trench and cutting exposed roots with sharp pruning instruments; do not break, tear, chop, or slant the cuts. Do not use a backhoe or other equipment that rips, tears, or pulls roots.
2. Cut Ends: Do not paint cut root ends.
3. Temporarily support and protect roots from damage until they are permanently redirected and covered with soil.
4. Cover exposed roots with burlap and water regularly.
5. Backfill as soon as possible according to requirements in Section 312000 "Earth Moving."

B. Root Pruning at Edge of Protection Zone: Prune tree roots 6 inches inside the protection zone by cleanly cutting all roots to the depth of the required excavation.

## 3.6 FIELD QUALITY CONTROL

A. Inspections: Engage a qualified arborist to direct plant-protection measures in the vicinity of trees, shrubs, and other vegetation indicated to remain and to prepare inspection reports.

## 3.7 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Disposal: Remove excess excavated material, displaced trees, trash, and debris and legally dispose of them off Owner's property.

END OF SECTION 015639

# SECTION 019113 – GENERAL COMMISSIONING REQUIREMENTS
# PART 1 - GENERAL

## 1.1 SUMMARY

A. Section includes the administrative requirements related to commissioning and includes the following:

1. Definitions
2. Coordination
3. Quality control
4. Submittals
5. Design review and documentation
6. Test equipment
7. Commissioning process
8. Commissioning scope meetings
9. Commissioning plans
10. Submittal review
11. Commissioning controls coordination meeting
12. Startup/Pre functional check lists
13. Functional performance testing
14. Issue log
15. Operations and maintenance training
16. Final commissioning report
17. Deferred seasonal testing
18. Team responsibilities

B. The Owner, Architect/Engineer, and Commissioning Agent are not responsible for construction means, methods, job safety, or management function related to commissioning on the job site.

1. The commissioning process does not take away from or reduce the responsibility of the system designers or installing contractors to provide a finished and fully functioning product.

2. The mention of a subcontractor is not meant to usurp the Contractor's responsibility to assign the work.

C. Related Sections:

1. 014000 Quality Requirements
2. 017700 Closeout Procedures
3. 017900 Demonstration and Training
4. 260000 General Requirements Electrical Systems
5. 260800 Commissioning Electrical System

1.2 DEFINITONS

A. Basis of Design (BOD): The Basis of Design document is a specific Commissioning document that describes the systems, components, conditions and methods chosen by the design engineer to meet the requirements of the project. Some reiteration of the Owner's Project Requirements may be included.

B. Commissioning (Cx): Commissioning is a comprehensive and systematic process to verify that the building systems perform as designed to meet the Owner's requirements. Commissioning during the construction, acceptance and warranty phases is intended to achieve the following specific objectives:

1. Verify and document that the equipment is installed and started per manufacturer's recommendations, industry accepted minimum standards, and the Contract Documents.

2. Verify and document that the equipment and systems receive complete operational checkout by installing contractors.

3. Verify and document equipment and system performance.

4. Verify the completeness of the Operations and Maintenance materials.

5. Ensure that the Owner's operating personnel are adequately trained on the operation and maintenance of building equipment.

6. The commissioning process does not take away from or reduce the responsibility of the systems designers or installing contractors to provide a finished and fully functioning product.

C. Commissioning Agent (CxA): The commissioning agent develops the functional test procedures in a sequential written form, coordinates, oversees, and documents the actual testing, which is usually performed by the installing contractor or vendor. Functional Performance Tests are performed after pre-functional checklists and startup is complete.

D. Commissioning Plan: The commissioning plan is an overall plan that provides the structure, schedule, and coordination planning for the commissioning process.

E. Deficiency: A deficiency is a condition in the installation or function of a component, piece of equipment, or system that is not in compliance with the Contract Documents, does not perform properly, or is not complying with the Owner's Project Requirements.

F. Owner's Project Requirements (OPR): The OPR is a specific Commissioning document that is updated throughout the project that provides the explanation of the ideas, concepts,

and criteria that are considered to be very important to the Owner. It is initially the outcome of the programming and conceptual design process.

G. Functional Performance Test (FPT): The FPT is a test of the dynamic function and operation of equipment and systems using manual (direct observation) or monitoring methods. Functional testing is the dynamic testing of systems (rather than just components) under full operation (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). Systems are tested under various modes, such as during low cooling or heating loads, high loads, component failure, unoccupied, varying outside air temperatures, fire alarm power failure, and any other operational sequence included in the system design. The systems are run through all the control system's sequences of operation and components are verified to be responding as the sequences state. Traditional air or water test and balancing (TAB) is not functional testing, in the commissioning sense of the word. TAB's primary work is setting up the system flows and pressures as specified, while functional testing is verifying that which has already been set up. The CxA develops the functional test procedures in a sequential written form, coordinates, oversees and documents the actual testing, which is usually performed by the installing contractor or vendor. Functional Performance Tests are performed after prefunctional checklists and startup is complete.

H. Prefunctional Checklist: The pre-functional check list is a list of items to inspect and elementary component test to conduct to verify proper installation of equipment, provided by the CxA to the contractor. Prefunctional checklists are primarily static inspections and procedures to prepare the equipment or system for initial operation (e.g. belt tension, oil levels OK, labels affixed, gages in place, sensors calibrated). However, some prefunctional checklist items entail system testing of the function of a component, a piece of equipment or system (such as measuring the voltage imbalance on a three-phase pump motor of a chiller system). The word "prefunctional" refers to before functional testing. Prefunctional checklists augment and are combined with the manufacturer's start-up checklist.

I. Warranty Period: The warranty period is for the entire project, including equipment components. Warranty begins at Substantial Completion and extends for two years, unless specifically noted otherwise in the Contract Documents and accepted submittals.

J. Abbreviations: The following are common abbreviations used in the Commissioning Specification:

1. A/E - Architect and Engineers
2. CxA - Commissioning Agent
3. CC - Controls Contractor
4. Cx Plan - Commissioning Plan document
5. FPT - Functional Performance Test

6. GC - General Contractor
7. MEP – Mechanical, Electrical, Plumbing
8. PM - Project Manager (University)
9. Subs - Subcontractors to the General Contractor
10. TAB - Test and Balance Contractor

1.3 COORDINATION

A. The owner will hire a third-party Commissioning Agent (CxA). The contractor and the contractor's team shall be responsible for assisting the CxA in commissioning activities.

B. Commissioning Agent (CxA) shall provide overall coordination and management of the commissioning program as specified herein.

C. Commissioning Team: The commissioning process will require the cooperation of the Contractor, subcontractors, vendors, Architect/Engineer, Commissioning Agent, and Owner. The commissioning team shall be comprised of the following. Team member responsibilities are listed in Part 3 of this section.

1. Commissioning Agent:

   a. Project Manager
   b. Project Technicians

2. Contractor and Sub-contractors as required.

3. Owner Representative(s)

4. Architect/Engineer:

   a. Architect
   b. MEP Engineers
   c. Specialty Consultant(s)

D. Progress Meetings: Attend construction job-site meetings, as necessary, to monitor construction and commissioning progress. Coordinate with contractor to address coordination, deficiency resolution, and planning issues.

1. Plan and coordinate additional meetings as needed based on work progress.

E. Site Observations: Perform site visits as necessary to observe component and system installations.

F. Functional Testing Coordination:

1. Equipment shall not be "temporarily" started for commissioning.
2. Functional performance testing shall not begin until pre-functional check, start-up, and TAB are completed for a given system.
3. The controls system and equipment controls shall not be functionally tested until all points have been calibrated and pre-functional checklists are complete.

1.4 QUALITY CONTROL

A. Engage commissioning service personnel that specialize in the types of inspections and tests to be performed.

B. The work included in the commissioning process involves a complete and thorough evaluation of the operation and performance of all components, systems and sub-systems of the systems to be commissioned.

1.5 SUBMITTALS

A. Cx Meeting Minutes:

1. CxA shall be responsible for preparing meeting minutes and provide to Owner's PM for distribution.

B. Commissioning Plan:

1. Contractor shall be responsible for reviewing the Commissioning plan, provided by the CxA, and incorporating into project schedule.

C. Pre-Functional Checklists:

1. Contractor shall be responsible for completing pre-functional checklists (prepared by CxA). The contractor shall allow five days for review of completed PFC's before FPT's are scheduled to begin.

**PART 2 - PRODUCTS**

2.1 TEST EQUIPMENT

A. The contractor will make available standard testing equipment required to perform startup, initial checkout and functional performance testing as well as any special tools and instruments (only available from vendor, specific to a piece of equipment) required for testing equipment according to these Contract Documents.

B. Data Logging equipment and software required to test equipment shall be provided by the Contractor, but shall not become property of the Owner.

C. Instrumentation shall meet the following standards:

1. Be of sufficient quality and accuracy to test and measure system performance within the tolerances required to determine adequate performance.
2. Be calibrated on the manufacturer's recommended intervals with calibration tags permanently affixed to the instrument being used.
3. Be maintained and in good repair and operational condition throughout the duration of use on this project.

D. Test Equipment Calibration Requirements: Contractors shall comply with test equipment manufacturer's calibration procedures and intervals. Recalibrate test instruments immediately after instruments have been repaired after being dropped or damaged. Affix calibration tags to test instruments. Furnish calibration records to CxA upon request.

## PART 3 - EXECUTION

### 3.1 COMMISSIONING PROCESS

A. The following activities outline the commissioning tasks and the general order in which they occur. The CxA shall coordinate all activities.

1. Design Review and Documentation:
    a. Basis of Design and Owner's Project Requirements Review
    b. Design Document Review
    c. Controls Coordination Review Meeting
    d. Construction Document Review
2. Commissioning Scoping Meetings
3. Commissioning Plan
4. Submittal Review:
    a. General systems to be Commissioned
    b. Controls Submittal Review
5. Commissioning Controls Coordination Meeting
6. Start-Up / Pre-functional Checklists
7. Functional Performance Testing
8. Issues Log
9. Operations and Maintenance Training
10. Final Commissioning Report
11. Deferred and Seasonal Testing

### 3.2 COMMISSIONING SCOPE MEETINGS

A. Commissioning Scope Meeting – Design Phase:

1. Attend a scope meeting during the design phase prior to the first design review.
2. Cx Team members who have been hired during the design phase shall be in attendance.

3. Review the Cx process with special attention on the design phase requirements.

B. Commissioning Scope Meeting – Construction Phase:

1. Attend a scoping meeting at the start of construction after the subcontractors have been selected.
2. All Cx Team members shall be in attendance.
3. Review the Cx process with special attention on the construction phase requirements.

## 3.3 COMMISSIONING CONTROLS COORDINATION MEETING

A. Meeting Attendees:

1. CxA
2. Controls Contractor
3. Engineer of Record
4. Owner's Representatives
5. Contractor
6. Architect

B. After the first controls submittal review is complete, schedule, coordinate and facilitate the Commissioning Controls Coordination Meeting.

C. Review all submittal review comments with the group and, as a group, determine the required resolution for each comment. Controls resubmittal shall be submitted within two (2) weeks of this meeting.

## 3.4 START-UP / PRE-FUNCTIONAL CHECKLISTS

A. Start-up/Pre-Functional Checklists: Coordinate start-up plans and documentation formats, including providing contractor with pre-functional checklists to be completed during the start-up process.

1. Manufacturer's start-up checklists and other technical documentation guidelines may be used as the basis for pre-functional checklists. CxA will coordinate with the Contractor to obtain manufacturer data as needed.

B. Start-up/Pre-Functional Checklists are used to verify that the systems are complete and operational before functional testing is scheduled.

## 3.5 FUNCTIONAL PERFORMANCE TESTING

A. Functional Performance Tests (FPT): Test procedures shall fully describe system configuration and steps required for each test; appropriately documented so that the test can be repeated with virtually identical results.

1. Test Methods: Functional performance testing and verification may be achieved using a combination of the following methods to test the complete sequence of operation. The CxA shall determine which method, or combination, is most appropriate:

    a. Direct manipulation of system inputs (i.e. applying heat or cold to sensors).
    b. Manipulation of system inputs with the building automation software (i.e. software override of sensor inputs)
    c. Direct observation of equipment readouts, gauges, and actuators.
    d. Trend logs of system inputs and outputs using the building automation system
    e. Short-term monitoring of system inputs and outputs using stand alone data loggers.

2. Setup: Setup each test procedure to be performed under conditions that simulate normal operating conditions as closely as possible. Where equipment requires integral safety devices to stop/prevent equipment operation unless minimum safety standards or conditions are met, functional performance test procedures shall demonstrate the actual performance of safety shutoffs in a real or closely-simulated condition of failure.

3. Sampling: Multiple identical pieces of non-life-safety or non-critical equipment may be functionally tested using a sampling strategy. The sampling strategy shall be developed by the CxA. If, after three attempts at testing the specified sample percentage, failures are still present, then all remaining units shall be tested at the contractor's expense. Sampling may only be used as agreed upon in the Cx contract.

4. Trending: Identify conditions where trend data from the building automation system or data loggers can be used to verify sequence of operation performance. Include trend log requirements in FPT documentation.

B. Assist CxA in completing FPT's as directed by the CxA.

## 3.6 ISSUES LOG

A. Issues are items of non-compliance in materials, installation, or operation observed by the CxA.

B. The CxA shall notify responsible parties upon observation of deficiencies or issues of non-compliance. CxA shall recommend corrective actions as appropriate. Issues that are not immediately resolved shall be placed on the Issues Log.

C. The CxA shall update the Issues Log and submit it to the PM for distribution to all members of the Cx Team when changes are made.

D. Those identified as "Responsible" for a specific issue shall respond within three (3) days of receiving an updated Issues Log with the planned resolution.

1. "Responsible" indicates the party who is responsible for responding to the open issue, it does not imply responsibility for creating the issue. For example, if the issue relates to a temperature set-point, the Owner may be listed as the responsible party for providing the desired value.

2. Any member of the design and construction team may be identified to respond to Cx Issues. Team members are responsible for responding to design and construction questions raised during commissioning work.

## 3.7 TEAM RESPONSIBILITIES

A. Owner's Responsibilities:

1. Owner will hire the third party CxA.

2. Provide the OPR documentation to the CxA and Contractors for use in developing the Cx Plan, testing plans, and checklists.

3. Provide the Basis of Design documents, prepared by the architect and approved by the Owner, for use in developing the Commissioning Plan; testing plans and checklists.

4. Assign operation and maintenance personnel and schedule them to participate in Commissioning Team activities including, but not limited to, the following:

a. Commissioning meetings.
b. Construction phase coordination meetings.
c. Piping and ductwork testing and flushing verification meetings.
d. Procedures meeting for testing, adjusting and balancing.
e. Testing and demonstration of systems, subsystems and equipment.
f. Training in operation and maintenance of systems, subsystems and equipment.
g. Final review and acceptance meetings.
h. Provide utility services required for the commissioning process.
i. Review and approve the commissioning plan.
j. Coordinate any seasonal or deferred testing.
k. Ensure that any seasonal, deferred testing and/or deficiency issues are addressed.

B. Architect / Engineer's Responsibilities:

1. Attend the Commissioning Scoping Meetings, Controls Coordination Meetings, and selected team meetings.

2. Perform submittal review, construction observation, as-built drawing preparation, and other items as contracted.

3. Provide the Basis of Design Document. The design engineers shall assist in clarifying the operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.

4. Participate in the resolution of system deficiencies and issues identified during the commissioning, according to the contract documents.

5. Insure that the CxA's submittal comments are incorporated into the Design Professional's submittal comments prior to sending to CM for distribution.

6. Participate in resolution of design non-conformance and design deficiencies identified during the warranty-period commissioning process.

C. Contractor, and Subcontractor Responsibilities:

1. 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 brief overview:

   a. Facilitate the coordination of commissioning and incorporate commissioning activities into the overall project.
   b. Provide copies of all applicable submittals as required in the specifications including all changes.
   c. Provide detailed startup procedures.
   d. Evaluate performance deficiencies identified in test reports and, in collaboration with entity responsible for system and equipment installation, perform corrective actions.
   e. Cooperate with the CxA for resolution of issues recorded in the Issues Log.
   f. Attend commissioning team meetings held on a scheduled basis.
   g. Make available a copy of all construction documents, addenda, change orders and approved submittals and shop drawings related to commissioned equipment to the CxA.
   h. Integrate and coordinate commissioning process activities with construction schedule.
   i. Review construction checklists provided by the CxA.

j. Review commissioning process test procedures provided by the CxA.
k. Complete commissioning process test procedures.
l. Submit training plan for approval, coordinate training and provide qualified instructors for training of Owner personnel.
m. Assist the CxA as necessary in the seasonal testing, deferred testing and deficiency resolution.
n. Ensure that subcontractors correct deficiencies and make necessary adjustments to submittals, O&M manuals and red-lined drawings for applicable issues identified during testing.
o. Provide as-built controls drawings and sequences of operation for all equipment.
p. Provide a written list of all user adjustable set-points and reset schedules with a brief discussion of the purpose of each and the range of reasonable adjustments with energy implications.

2. Equipment Supplier Responsibilities:

a. Provide all requested submittal data, including detailed start-up procedures and specific responsibilities of the Owner to keep warranties in force.
b. Assist in equipment testing per agreements with subcontractors.
c. Provide information requested by the CxA regarding equipment sequence of operation and testing procedures.

3. Commissioning Agent Responsibilities:

a. Roles and Responsibilities:

1) The CxA is not responsible for the design concept, the design criteria, compliance with codes, design or general construction scheduling, cost estimating or construction management.
2) The CxA may assist with problem solving and non-conformance items or deficiencies, but the CxA is not the Engineer of Record, and the commissioning process does not preclude the Engineer of Record of responsibilities for system evaluations, adequacy of systems to meet the OPR, capacities of systems, quality control checks, or any of the other elements and recommended final acceptance of systems to the Owner.
3) The primary role of the CxA is to coordinate and direct the commissioning activities in a logical, sequential and efficient manner using consistent protocols and forms, centralized documentation, clear and regular communications and consultants with all necessary parties, frequently updated timelines and schedules and technical expertise.

b. Commissioning Plan:

1) The CxA shall develop a Commissioning Plan at the start of the project.
2) At the end of the Project, the CxA shall provide the Owner with the Final Commissioning Plan for the Owner's use.

c. Document Review:

1) Review the Owner's Project Requirements and Basis of Design developed by the design professionals.
2) Perform two (2) focused reviews of the drawings and specification during design phase.
3) Develop full commissioning specifications for all systems and equipment to be commissioned. The commissioning specifications will be subject to approval of the design team and included in the final construction specifications.
4) Review submittals applicable to systems being commissioned for compliance for commissioning needs, concurrent with the AE's reviews.

d. Cx Team Meetings:

1) Lead Cx Meetings during design and construction.

e. Coordination and Scheduling:

1) Coordinate and direct commissioning activities in a logical, sequential and efficient manner using consistent protocols and forms, centralized documentation, clear and regular communications, and consultations with all necessary parties.
2) Coordinate commissioning work with the CM to ensure that commissioning activities are being scheduled into the master project schedule.

f. Commissioning Progress:

1) Perform site visits, as necessary, to observe component and system installations.
2) Attend selected planning and jobsite meetings to obtain information on construction progress.
3) Review construction meeting minutes for revisions/substitutions relating to the commissioning process.

g. Pre-Functional Checks:

1) Verify proper installation of components, equipment, systems and assemblies.

h. Equipment and System Startup and Verification:

1) Review system startup reports and conduct selected site observation.
2) Perform TAB verification per contract requirements, and review the TAB report prior to functional testing.
3) Functional Performance Testing
4) With assistance from the Contractor, write Functional Performance Test procedures for all components, equipment or systems to be commissioned.
5) With the assistance of the Contractors, coordinate Functional Performance Testing. Witness and approve Functional Performance Testing performed by the Contractors.

i. With the assistance of the Contractors, coordinate retesting as necessary until satisfactory performance is achieved.
j. Witness seasonal or deferred Functional Performance Testing as necessary.

4. Issue/Deficiency Logs:

a. Prepare a formal, ongoing, online record of deficiencies, problems and concerns – and their resolution – raised by members of the Commissioning Team during the Commissioning Process.
b. Issues will be recorded in the Issues Log. The AE, CM/GC and Contractors will resolve all issues to the satisfaction of the Owner. Issues will be added by the CxA. Team members are required to respond to issues pertaining to their work. Team members are required to respond to issues added to the list within five (5) working days of issue of an update to the Issues Log.
c. When issues are resolved, they will be closed on the Issues Log by the CxA.

5. Operation and Maintenance Data:

a. The CxA shall review of the documentation submitted by the Contractor as required by the Specifications for completeness and accuracy. This commissioning review supplements, but does not replace, the Architect/Engineer's review.
b. Review equipment warranties to ensure that the Owner's responsibilities are clearly defined.

6. Training:

   a. The CM/GC and Contractors will provide all documentation and qualified training personnel for training.
   b. The CxA will verify through the Contractor's plan and schedule, training agendas, and attendance documentation that proper training procedures were followed on all commissioned systems.
   c. See specifications for training requirements.

7. Commissioning Final Report:

   a. The CxA shall provide a final report following the completion of all Functional Performance Testing.

END OF SECTION 019100

# SECTION 024119 - SELECTIVE DEMOLITION

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:

1. Demolition and removal of selected portions of building or structure.
2. Demolition and removal of selected site elements.
3. Salvage of existing items to be reused or recycled.

B. Related Requirements:

1. Section 015639 "Temporary Tree and Plant Protection" for temporary protection of existing trees and plants that are affected by selective demolition.
2. Section 311000 "Site Clearing" for site clearing and removal of above- and below-grade improvements.

### 1.3 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: Carefully detach from existing construction, in a manner to prevent damage, and deliver to Owner ready for reuse.

C. Remove and Reinstall: Detach items from existing construction, prepare for reuse, and reinstall where indicated.

D. Existing to Remain: Existing items of construction that are not to be permanently removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

### 1.4 MATERIALS OWNERSHIP

A. Unless otherwise indicated, demolition waste becomes property of Contractor.

B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Owner that may be uncovered during demolition remain the property of Owner.

1. Carefully salvage in a manner to prevent damage and promptly return to Owner.

## 1.5 PREINSTALLATION MEETINGS

A. Predemolition Conference: Conduct conference at Project site.

1. Inspect and discuss condition of construction to be selectively demolished.
2. Review structural load limitations of existing structure.
3. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
4. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.
5. Review areas where existing construction is to remain and requires protection.

## 1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For refrigerant recovery technician.

B. Proposed Protection Measures: Submit report, including drawings, that indicates the measures proposed for protecting individuals and property, for environmental protection, for dust control and, for noise control. Indicate proposed locations and construction of barriers.

C. Schedule of Selective Demolition Activities: Indicate the following:

1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure Owner's facility manager's on-site operations are uninterrupted.
2. Interruption of utility services. Indicate how long utility services will be interrupted.
3. Coordination for shutoff, capping, and continuation of utility services.
4. Use of elevator and stairs.
5. Coordination of Owner's continuing occupancy of portions of existing building and of Owner's partial occupancy of completed Work.

D. Inventory: Submit a list of items to be removed and salvaged and deliver to Owner prior to start of demolition.

E. Predemolition Photographs or Video: Submit before Work begins.

F. Warranties: Documentation indicated that existing warranties are still in effect after completion of selective demolition.

## 1.7 CLOSEOUT SUBMITTALS

A. Inventory: Submit a list of items that have been removed and salvaged.

B. Landfill Records: Indicate receipt and acceptance of hazardous wastes by a landfill facility licensed to accept hazardous wastes.

## 1.8 FIELD CONDITIONS

A. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.

B. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with selective demolition.

C. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.

1. If suspected hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Hazardous materials will be removed under a separate contract.

D. Storage or sale of removed items or materials on-site is not permitted.

## 1.9 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. Notify warrantor before proceeding.

B. Notify warrantor on completion of selective demolition, and obtain documentation verifying that existing system has been inspected and warranty remains in effect. Submit documentation at Project closeout.

## PART 2 - PRODUCTS

2.1 PEFORMANCE REQUIREMENTS

A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

B. Standards: Comply with ANSI/ASSE A10.6 and NFPA 241.

## PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that utilities have been disconnected and capped before starting selective demolition operations.

B. Review record documents of existing construction provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in record documents.

C. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.

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 Architect.

E. Engage a professional engineer to perform an engineering survey of condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during selective building demolition operations.

1. Perform surveys as the Work progresses to detect hazards resulting from selective demolition activities.
2. Steel Tendons: Locate tensioned steel tendons and include recommendations for de-tensioning.

F. Survey of Existing Conditions: Record existing conditions by use of measured drawings and preconstruction photographs or preconstruction videotapes.

1. Comply with requirements specified in Section 013233 "Photographic Documentation."

2. Inventory and record the condition of items to be removed and salvaged. Provide photographs or video of conditions that might be misconstrued as damage caused by salvage operations.
3. Before selective demolition or removal of existing building elements that will be reproduced or duplicated in final Work, make permanent record of measurements, materials, and construction details required to make exact reproduction.

## 3.2 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.

1. Comply with requirements for existing services/systems interruptions specified in Section 011000 "Summary."

B. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off indicated utility services and mechanical/electrical systems serving areas to be selectively demolished.

1. Owner will arrange to shut off indicated services/systems when requested by Contractor.
2. Arrange to shut off indicated utilities with utility companies.
3. If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
4. Disconnect, demolish, and remove fire-suppression systems, plumbing, and HVAC systems, equipment, and components indicated to be removed.

    a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
    b. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
    c. Equipment to Be Removed: Disconnect and cap services and remove equipment.
    d. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
    e. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
    f. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
    g. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.

C. Refrigerant: Remove refrigerant from mechanical equipment to be selectively demolished according to 40 CFR 82 and regulations of authorities having jurisdiction.

D. Demolition in the vicinity Electrical Transmission Duct Bank: Contact utility owner prior to any demolition in the vicinity of an electric transmission duct bank. Coordinate with utility owner and follow all guidelines and requirements set forth by the utility owner. Any excavation within 20-feet of the electric transmission duct bank shall have the utility owner's representative on-site and shall be performed by hand.

## 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. Comply with requirements for access and protection specified in Section 015000 "Temporary Facilities and Controls."

B. Temporary Facilities: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.

1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
2. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.
3. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
4. Cover and protect furniture, furnishings, and equipment that have not been removed.
5. Comply with requirements for temporary enclosures, dust control, heating, and cooling specified in Section 015000 "Temporary Facilities and Controls."

C. Temporary Shoring: Provide and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.

1. Strengthen or add new supports when required during progress of selective demolition.

## 3.4 SELECTIVE DEMOLITION, GENERAL

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 and as follows:

1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.
2. 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. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, to minimize disturbance of adjacent surfaces. Temporarily cover openings to remain.
3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
4. 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.
5. Maintain adequate ventilation when using cutting torches.
6. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
7. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
8. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
9. Dispose of demolished items and materials promptly. Comply with requirements in Section 017419 "Construction Waste Management and Disposal."

B. Work in Historic Areas: Selective demolition may be performed only in areas of the Project that are not designated as historic. In historic spaces, areas, and rooms or on historic surfaces, the terms "demolish" or "remove" shall mean historic "removal" or "dismantling" as specified in Section 013591 "Historic Treatment Procedures."

C. 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 Owner.
4. Transport items to Owner's storage area designated by Owner.
5. Protect items from damage during transport and storage.

D. Removed and Reinstalled Items:

1. Clean and repair items to functional condition adequate for intended reuse.

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.

E. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Architect, items may be removed to a suitable, protected storage location during selective demolition cleaned and reinstalled in their original locations after selective demolition operations are complete.

## 3.5 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

A. Concrete: Demolish in small sections. Using power-driven saw, cut concrete to a depth of at least 3/4 inch at junctures with construction to remain. Dislodge concrete from reinforcement at perimeter of areas being demolished, cut reinforcement, and then remove remainder of concrete. Neatly trim openings to dimensions indicated.

B. Concrete: Demolish in sections. Cut concrete full depth at junctures with construction to remain and at regular intervals using power-driven saw, then remove concrete between saw cuts.

C. Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw, then remove masonry between saw cuts.

D. Concrete Slabs-on-Grade: Saw-cut perimeter of area to be demolished, then break up and remove.

E. General: Except for items or materials indicated to be recycled, reused, salvaged, reinstalled, or otherwise indicated to remain Owner's property, remove demolished materials from Project site and legally dispose of them in an EPA-approved landfill.

1. Do not allow demolished materials to accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
3. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
4. Comply with requirements specified in Section 017419 "Construction Waste Management and Disposal."

F. Burning: Do not burn demolished materials.

G. Disposal: Transport demolished materials off Owner's property and legally dispose of them.

3.6 CLEANING

A. 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.

END OF SECTION 024119

# SECTION 033000 - CAST-IN-PLACE CONCRETE

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section includes cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes.

B. Related Requirements:

1. Section 033300 "Architectural Concrete" for general building applications of specially finished formed concrete.

2. Section 033816 “Unbonded Post-Tensioned Concrete” for post-tensioned floor construction.
3. Section 312000 "Earth Moving" for drainage fill under slabs-on-grade.
4. Section 321313 "Concrete Paving" for concrete pavement and walks.
5. Section 321316 "Decorative Concrete Paving" for decorative concrete pavement and walks.

### 1.3 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash, slag cement, other pozzolans, and silica fume; materials subject to compliance with requirements.

B. W/C Ratio: The ratio by weight of water to cementitious materials.

### 1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:

a. Contractor's superintendent.
b. Independent testing agency responsible for concrete design mixtures.
c. Ready-mix concrete manufacturer.
d. Concrete Subcontractor.

2. Review special inspection and testing and inspecting agency procedures for field quality control, concrete finishes and finishing, cold- and hot-weather concreting procedures, curing procedures, construction contraction and isolation joints, and joint-filler strips, forms and form removal limitations, vapor-retarder installation, anchor rod and anchorage device installation tolerances, steel reinforcement installation, methods for achieving specified floor and slab flatness and levelness floor and slab flatness and levelness measurement, concrete repair procedures, and concrete protection.

## 1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
3. Laboratory Test Reports: For liquid floor treatments and curing and sealing compounds, indicating compliance with requirements for low-emitting materials.

C. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1. Indicate amounts of mixing water to be withheld for later addition at Project site.

D. Steel Reinforcement Shop Drawings: Placing Drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.

E. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.

1. Location of construction joints is subject to approval of the Architect.

F. Samples: For waterstops and vapor retarder.

## 1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Material Certificates: For each of the following, signed by manufacturers:

1. Cementitious materials.
2. Admixtures.
3. Form materials and form-release agents.
4. Steel reinforcement and accessories.
5. Fiber reinforcement.
6. Waterstops.
7. Curing compounds.
8. Floor and slab treatments.
9. Bonding agents.
10. Adhesives.
11. Vapor retarders.
12. Semirigid joint filler.
13. Joint-filler strips.
14. Repair materials.

C. Material Test Reports: For the following, from a qualified testing agency:

1. Aggregates: Include service record data indicating absence of deleterious expansion of concrete due to alkali aggregate reactivity.

D. Formwork Shop Drawings: Prepared by or under the supervision of a qualified professional engineer, detailing fabrication, assembly, and support of formwork.

1. Shoring and Reshoring: Indicate proposed schedule and sequence of stripping formwork, shoring removal, and reshoring installation and removal.

E. Floor surface flatness and levelness measurements indicating compliance with specified tolerances.

F. Field quality-control reports.

G. Minutes of preinstallation conference.

## 1.7 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs on Project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.

B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

C. Testing Agency Qualifications: An independent agency, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.

1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
2. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician, Grade I. Testing agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician, Grade II.

D. Welding Qualifications: Qualify procedures and personnel according to AWS D1.4/D 1.4M.

## 1.8 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on concrete mixtures.

## 1.9 DELIVERY, STORAGE, AND HANDLING

A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage. Avoid damaging coatings on steel reinforcement.

B. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

## 1.10 FIELD CONDITIONS

A. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

1. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.

2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.

B. Hot-Weather Placement: Comply with ACI 301 and as follows:

1. Maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

## PART 2 - PRODUCTS

### 2.1 CONCRETE, GENERAL

A. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:

1. ACI 301.
2. ACI 117.

### 2.2 FORM-FACING MATERIALS

A. Smooth-Formed Finished Concrete: Form-facing panels that provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.

1. Plywood, metal, or other approved panel materials.
2. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:

    a. High-density overlay, Class 1 or better.
    b. Medium-density overlay, Class 1 or better; mill-release agent treated and edge sealed.
    c. Structural 1, B-B or better; mill oiled and edge sealed.
    d. B-B (Concrete Form), Class 1 or better; mill oiled and edge sealed.

3. Overlaid Finnish birch plywood.

B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.

C. Forms for Cylindrical Columns, Pedestals, and Supports: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes that produce surfaces with gradual or abrupt irregularities not exceeding specified formwork surface class. Provide units with sufficient wall thickness to resist plastic concrete loads without detrimental deformation.

D. Pan-Type Forms: Glass-fiber-reinforced plastic or formed steel, stiffened to resist plastic concrete loads without detrimental deformation.

E. Void Forms: Biodegradable paper surface, treated for moisture resistance, structurally sufficient to support weight of plastic concrete and other superimposed loads.

F. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch, minimum.

G. Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.

H. Form-Release Agent: Commercially formulated form-release agent that does not bond with, stain, or adversely affect concrete surfaces and does not impair subsequent treatments of concrete surfaces.

1. Formulate form-release agent with rust inhibitor for steel form-facing materials.

I. Form Ties: Factory-fabricated, removable or snap-off glass-fiber-reinforced plastic or metal form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.

1. Furnish units that leave no corrodible metal closer than 1 inch to the plane of exposed concrete surface.
2. Furnish ties that, when removed, leave holes no larger than 1 inch in diameter in concrete surface.
3. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

## 2.3 STEEL REINFORCEMENT

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 60 percent.

B. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.

C. Low-Alloy-Steel Reinforcing Bars: ASTM A 706/A 706M, deformed.

D. Galvanized Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed bars, ASTM A 767/A 767M, Class II zinc coated after fabrication and bending.

E. Epoxy-Coated Reinforcing Bars: ASTM A 615/A 615M, Grade 60 deformed bars, ASTM A 775/A 775M, epoxy coated, with less than 2 percent damaged coating in each 12-inch bar length.

F. Stainless-Steel Reinforcing Bars: ASTM A 955/A 955M, Grade 60, Type 316L, deformed.

G. Steel Bar Mats: ASTM A 184/A 184M, fabricated from ASTM A 615/A 615M, Grade 60, deformed bars, assembled with clips.

H. Plain-Steel Wire: ASTM A 1064/A 1064M, as drawn.

I. Deformed-Steel Wire: ASTM A 1064/A 1064M.

J. Epoxy-Coated Wire: ASTM A 884/A 884M, Class A, Type 1 coated, as-drawn, plain - steel wire, with less than 2 percent damaged coating in each 12-inch wire length.

K. Plain-Steel Welded-Wire Reinforcement: ASTM A 1064/A 1064M, plain, fabricated from as-drawn steel wire into flat sheets.

L. Deformed-Steel Welded-Wire Reinforcement: ASTM A 1064/A 1064M, flat sheet.

M. Galvanized-Steel Welded-Wire Reinforcement: ASTM A 1064/A 1064M, plain, fabricated from galvanized-steel wire into flat sheets.

N. Epoxy-Coated Welded-Wire Reinforcement: ASTM A 884/A 884M, Class A coated, Type 1, plain steel.

## 2.4 REINFORCEMENT ACCESSORIES

A. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60, plain-steel bars, cut true to length with ends square and free of burrs.

B. Epoxy-Coated Joint Dowel Bars: ASTM A 615/A 615M, Grade 60, plain-steel bars, ASTM A 775/A 775M epoxy coated.

C. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating; compatible with epoxy coating on reinforcement and complying with ASTM A 775/A 775M.

D. Zinc Repair Material: ASTM A 780/A 780M.

E. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:

1. For concrete surfaces exposed to view, where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless-steel bar supports.
2. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.
3. For zinc-coated reinforcement, use galvanized wire or dielectric-polymer-coated wire bar supports.

## 2.5 CONCRETE MATERIALS

A. Regional Materials: Concrete shall be manufactured within 500 miles of Project site from aggregates and cementitious materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site.

B. Regional Materials: Concrete shall be manufactured within 500 miles of Project site.

C. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.

D. Cementitious Materials:

1. Portland Cement: ASTM C 150/C 150M, Type I, Type II, Type I/II, or Type III; gray.
2. Fly Ash: ASTM C 618, Class F or C.
3. Slag Cement: ASTM C 989/C 989M, Grade 100 or 120.
4. Silica Fume: ASTM C 1240, amorphous silica.

E. Normal-Weight Aggregates: ASTM C 33/C 33M, Class 4S for exterior, Class 4M for interior, coarse aggregate or better, graded. Provide aggregates from a single source.

1. Maximum Coarse-Aggregate Size: 1 inch nominal.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

F. Lightweight Aggregate: ASTM C 330/C 330M, 3/4-inch nominal maximum aggregate size.

G. Air-Entraining Admixture: ASTM C 260/C 260M.

H. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and that do not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.

1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
2. Retarding Admixture: ASTM C 494/C 494M, Type B.

3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

I. Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete and complying with ASTM C 494/C 494M, Type C.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:

a. BASF Corporation-Construction Systems; MasterLife CI 30 (Pre-2014: Rheocrete CNI).
b. Euclid Chemical Company (The); an RPM company; EUCON CIA.
c. Grace Construction Products; W.R. Grace & Co. -- Conn.; DCI.
d. Sika Corporation; Sika CNI.

J. Non-Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, non-set-accelerating, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete.

1. Products: Subject to compliance with requirements, provide one of the following:

a. BASF Corporation-Construction Systems; MasterLife CI 222 (Pre-2014: Rheocrete 222+).
b. Cortec Corporation; MCI- 2005NS.
c. Grace Construction Products; W.R. Grace & Co. -- Conn.; DCI-S.
d. Sika Corporation; FerroGard 901.

K. Water: ASTM C 94/C 94M and potable.

## 2.6 FIBER REINFORCEMENT

A. Synthetic Micro-Fiber: Fibrillated polypropylene micro-fibers engineered and designed for use in concrete, complying with ASTM C 1116/C 1116M, Type III, 1/2 to 1-1/2 incheslong.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Euclid Chemical Company (The); an RPM company; PSI Fiberstrand F.
b. FORTA Corporation; FORTA Econo-Net, FORTA Super-Net, FORTA Ultra-net.

c. Grace Construction Products; W.R. Grace & Co. -- Conn.; Grace Fibers.
d. Nycon, Inc.; ProCon-F -–E, [ProConF.
e. Propex; Fibermesh 300.
f. Sika Corporation; Sika Fiber PPF.

## 2.7 WATERSTOPS

A. Flexible Rubber Waterstops: CE CRD-C 513,[ with factory-installed metal eyelets,] for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.

1. Products: Subject to compliance with requirements, provide the following:

a. Williams Products, Inc; <Insert product designation>.

2. Profile: [Flat dumbbell with center bulb] [Flat dumbbell without center bulb] [Ribbed with center bulb] [Ribbed without center bulb] [As indicated] <Insert profile>.
3. Dimensions: [4 inches by 3/16 inch thick] [6 inches by 3/8 inch thick] [9 inches by 3/8 inch thick] <Insert dimensions>; nontapered.

B. Chemically Resistant Flexible Waterstops: Thermoplastic elastomer rubber waterstops[ with factory-installed metal eyelets], for embedding in concrete to prevent passage of fluids through joints; resistant to oils, solvents, and chemicals. Factory fabricate corners, intersections, and directional changes.

1. Products: Subject to compliance with requirements, provide one of the following:

a. JP Specialties, Inc.; Earth Shield TPV.
b. Sika Corporation; WESTEC Envirostop.

2. Profile: [Flat dumbbell with center bulb] [Flat dumbbell without center bulb] [Ribbed with center bulb] [Ribbed without center bulb] [As indicated] <Insert profile>.
3. Dimensions: [4 inches by 3/16 inch thick] [6 inches by 3/16 inch thick] [6 inches by 3/8 inch thick] [9 inches by 3/16 inch thick] [9 inches by 3/8 inch thick] <Insert dimensions>; nontapered.

C. Flexible PVC Waterstops: CE CRD-C 572,[ with factory-installed metal eyelets,] for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.

1. Products: Subject to compliance with requirements, provide one of the following:

a. BoMetals, Inc; <Insert product designation>.
b. Paul Murphy Plastics Company; <Insert product designation>.

c. Sika Greenstreak; Sika Greenstreak PVC Waterstop.
d. Vinylex Waterstop & Accessories; <Insert product designation>.

2. Profile: [Flat dumbbell with center bulb] [Flat dumbbell without center bulb] [Ribbed with center bulb] [Ribbed without center bulb] [As indicated] <Insert profile>.
3. Dimensions: [4 inches by 3/16 inch thick] [6 inches by 3/8 inch thick] [9 inches by 3/8 inch thick] <Insert dimensions>; nontapered.

D. Self-Expanding Butyl Strip Waterstops: Manufactured rectangular or trapezoidal strip, butyl rubber with sodium bentonite or other hydrophilic polymers, for adhesive bonding to concrete, 3/4 by 1 inch.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Carlisle Coatings & Waterproofing Inc; MiraSTOP.
b. CETCO, a Minerals Technologies company; [Waterstop-RX-101] [Waterstop-RX-101T] [Waterstop-RX-102].
c. Concrete Sealants Inc.; Conseal CS-231.
d. Henry Company, Sealants Division; Hydro-Flex.
e. JP Specialties, Inc.; Earth Shield Type 20.
f. Sika Greenstreak; Swellstop.

E. Self-Expanding Rubber Strip Waterstops: Manufactured rectangular or trapezoidal strip, bentonite-free hydrophilic polymer-modified chloroprene rubber, for adhesive bonding to concrete, 3/8 by 3/4 inch.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Adeka Ultra Seal/OCM, Inc.; [Adeka Ultra Seal MC-2005T] [Adeka Ultra Seal MC-2010MN].
b. CETCO, a Minerals Technologies company; Akwastop.
c. Grace Construction Products; W.R. Grace & Co. -- Conn.; Adcor ES.
d. Sika Greenstreak; Hydrotite.

## 2.8 VAPOR RETARDERS

A. Sheet Vapor Retarder: ASTM E 1745, Class A[, except with maximum water-vapor permeance of <Insert rating>]. Include manufacturer's recommended adhesive or pressure-sensitive tape.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Fortifiber Building Systems Group; [Moistop Ultra 10] [Moistop Ultra 15].
b. Grace Construction Products; W.R. Grace & Co. -- Conn.; Florprufe 120.

c. Insulation Solutions, Inc.; [Viper VaporCheck II 10-mil] [Viper VaporCheck II 15-mil].
d. Poly-America, L.P.; [Husky Yellow Guard Vapor Barrier 15 Mil ASTM E-1745 Class A] [Husky Yellow Guard Vapor Retarder 10 Mil ASTM E-1745 Class A].
e. Raven Industries, Inc; [Vapor Block 10] [Vapor Block 15] [Vapor Block VB10] [Vapor Block VB15].
f. Reef Industries, Inc; [Griffolyn 10 mil Green] [Griffolyn 15 mil Green] [Griffolyn Type-105] [Griffolyn Type-65G].
g. Stego Industries, LLC; [Stego Wrap 10 mil Class A] [Stego Wrap 15 mil Class A].
h. Tex-Trude, Inc.; [Xtreme 10 Mil Underslab Vapor Barrier] [Xtreme 15 mil Vapor Barrier] [Xtreme 20 mil Vapor Barrier].
i. W.R. Meadows, Inc; [Perminator 10 mil] [Perminator 15 mil].

B. Sheet Vapor Retarder: ASTM E 1745, Class B[, except with maximum water-vapor permeance of <Insert rating>]. Include manufacturer's recommended adhesive or pressure-sensitive tape.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Fortifiber Building Systems Group; Moistop Ultra 6.
b. Reef Industries, Inc; [Griffolyn 10 mil Green] [Griffolyn Type-85] [Griffolyn Vaporguard].

C. Sheet Vapor Retarder: ASTM E 1745, Class C[, except with maximum water-vapor permeance of <Insert rating>]. Include manufacturer's recommended adhesive or pressure-sensitive joint tape.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Insulation Solutions, Inc.; [Viper VaporCheck II 10 mil] [Viper VaporCheck II 6-mil].
b. Raven Industries, Inc; Vapor Block VB6.
c. Reef Industries, Inc; Griffolyn Type-65.
d. Stego Industries, LLC; Stego Wrap, 10 mil Class C.
e. Tex-Trude, Inc.; Xtreme 10 mil Class C.

D. Sheet Vapor Retarder: Polyethylene sheet, ASTM D 4397, not less than 10 mils thick.

E. Bituminous Vapor Retarder: 110-mil- thick, semiflexible, seven-ply sheet membrane consisting of reinforced core and carrier sheet with fortified asphalt layers, protective weathercoating, and removable plastic release liner. Furnish manufacturer's accessories, including bonding asphalt, pointing mastics, and self-adhering joint tape.

1. Products: Subject to compliance with requirements, provide the following:

a. W.R. Meadows, Inc; Premoulded Membrane Vapor Seal.

2. Water-Vapor Permeance: 0.0011 grains/h x sq. ft. x inches Hg; ASTM E 154.

3. Tensile Strength: 140 lbf/inch; ASTM E 154.
4. Puncture Resistance: 90 lbf; ASTM E 154.

## 2.9 FLOOR AND SLAB TREATMENTS

A. Slip-Resistive Emery Aggregate Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive, crushed emery aggregate containing not less than 50 percent aluminum oxide and not less than 20 percent ferric oxide; unaffected by freezing, moisture, and cleaning materials with 100 percent passing [3/8-inch] [No. 4] [No. 8] <Insert size or gradation> sieve.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

a. Anti-Hydro International, Inc; A-H Emery Non-Slip.
b. Dayton Superior; [Emery Non-Slip][Emery Tuff Top].
c. L&M Construction Chemicals, Inc; Grip It.
d. Lambert Corporation; EMAG-20.
e. Metalcrete Industries; Met-Top E.

B. Slip-Resistive Aluminum Granule Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive aggregate of not less than 95 percent fused aluminum-oxide granules.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Anti-Hydro International, Inc; A-H Alox.
b. BASF Corporation-Construction Systems; MasterTop 120 SR (Pre-2014: Frictex NS).
c. L&M Construction Chemicals, Inc; Grip It AO.

C. Emery Dry-Shake Floor Hardener: [Pigmented] [Unpigmented], factory-packaged, dry combination of portland cement, graded emery aggregate, and plasticizing admixture; with emery aggregate consisting of no less than 60 percent of total aggregate content.

1. Color: [As indicated by manufacturer's designation] [Match Architect's sample] [As selected by Architect from manufacturer's full range].

D. Metallic Dry-Shake Floor Hardener: [Pigmented] [Unpigmented], factory-packaged, dry combination of portland cement, graded metallic aggregate, rust inhibitors, and

plasticizing admixture; with metallic aggregate consisting of no less than 65 percent of total aggregate content.

1. Color: [As indicated by manufacturer's designation] [Match Architect's sample] [As selected by Architect from manufacturer's full range].

E. Unpigmented Mineral Dry-Shake Floor Hardener: Factory-packaged dry combination of portland cement, graded quartz aggregate, and plasticizing admixture.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. BASF Corporation-Construction Systems; Maximent HD.
   b. Dayton Superior; Quartz Tuff.
   c. Euclid Chemical Company (The); an RPM company; Surflex.
   d. Kaufman Products, Inc; Tycron.
   e. L&M Construction Chemicals, Inc; Quartzplate FF.
   f. Lambert Corporation; Colorhard.
   g. Metalcrete Industries; Floor Quartz.
   h. Scofield, L. M. Company; Lithochrome Color Hardener.
   i. SpecChem, LLC; Quartz Hardener.

F. Pigmented Mineral Dry-Shake Floor Hardener: Factory-packaged, dry combination of portland cement, graded quartz aggregate, color pigments, and plasticizing admixture. Use color pigments that are finely ground, nonfading mineral oxides interground with cement.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Anti-Hydro International, Inc; A-H S-Q Hardener.
   b. BASF Corporation-Construction Systems; MasterTop 100 (Pre-2014: Mastercron).
   c. Bon Tool Co.; BonWay Concrete Color Hardener.
   d. Brickform; a division of Solomon Colors; CH-Color Hardener.
   e. Butterfield Color; Perma-Cast Shake-On Color Hardener.
   f. Dayton Superior; Quartz Tuff.
   g. Decosup Inc.; HardBright Color Hardener.
   h. Dynamic Color Solutions, Inc; Dynamicast Color Hardener.
   i. Euclid Chemical Company (The); an RPM company; Surflex.
   j. H&C Concrete Care Products; Dry-Shake Color Hardener.
   k. Kaufman Products, Inc; Tycron.
   l. L&M Construction Chemicals, Inc; Quartz Plate FF.
   m. Lambert Corporation; Colorhard.
   n. Metalcrete Industries; Floor Quartz.
   o. Proline Concrete Tools, Inc.; Dura-Color Hardener.
   p. QC Construction Products; [QC Color Hardener] [QC Heavy-Duty Color Hardener].

q. Scofield, L. M. Company; Lithochrome Color Hardener.
r. SpecChem, LLC; Quartz Hardener - Colored.
s. Specialty Concrete Products, Inc; CHROME-HARD Color Hardener.
t. Stampcrete International, Ltd; Color Hardener.
u. SuperStone, Inc; Color Hardener.
v. SureCrete Design Products; Color Hardener.

2. Color: [As indicated by manufacturer's designation] [Match Architect's sample] [As selected by Architect from manufacturer's full range].

## 2.10 LIQUID FLOOR TREATMENTS

A. Penetrating Liquid Floor Treatment: Clear, chemically reactive, waterborne solution of inorganic silicate or siliconate materials and proprietary components; odorless; that penetrates, hardens, and densifies concrete surfaces.

1. Products: Subject to compliance with requirements, provide one of the following:

a. AWRC Corporation; AMERI-SHIELD Shield-Proof.
b. ChemMasters, Inc; Chemisil Plus.
c. ChemTec Int'l; ChemTec One.
d. Curecrete Distribution Inc.; Ashford Formula.
e. Dayton Superior; [Pentra-Hard Densifier] [Pentra-Hard Finish] [Pentra-Hard Guard] [Sure Hard Densifier J17].
f. Euclid Chemical Company (The); an RPM company; Euco Diamond Hard.
g. Kaufman Products, Inc; SureHard.
h. L&M Construction Chemicals, Inc; Seal Hard.
i. Metalcrete Industries; Floorsaver.
j. Nox-Crete Products Group; Duro-Nox.
k. PROSOCO, Inc; Consolideck LS by PROSOCO.
l. SpecChem, LLC; SpecHard.
m. US SPEC, Division of US MIX Company; US SPEC Industraseal.
n. Vexcon Chemicals Inc.; Vexcon StarSeal PS Clear.
o. W.R. Meadows, Inc; LIQUI-HARD.

2. Products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

## 2.11 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. BASF Corporation-Construction Systems; Confilm.
    b. Bon Tool Co.; 32-301-B7 BonWay Evaporation Retarder.
    c. Brickform; a division of Solomon Colors; Evaporation Retarder.
    d. ChemMasters, Inc; Spray-Film.
    e. Dayton Superior; AquaFilm Concentrate J74 or AquaFilm J74RTU.
    f. Euclid Chemical Company (The); an RPM company; Eucobar.
    g. Kaufman Products, Inc; VaporAid.
    h. L&M Construction Chemicals, Inc; E-CON.
    i. Lambert Corporation; LAMBCO Skin.
    j. Metalcrete Industries; Waterhold.
    k. Nox-Crete Products Group; MONOFILM.
    l. Sika Corporation; Caltexol CIMFILM or SikaFilm.
    m. SpecChem, LLC; Spec Film.
    n. TK Products; TK-2120 TRI-FILM.
    o. Vexcon Chemicals Inc.; Certi-Vex EnvioAssist.
    p. W.R. Meadows, Inc; EVAPRE.

B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.

C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

D. Water: Potable.

E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, 18 to 25 percent solids, nondissipating, certified by curing compound manufacturer to not interfere with bonding of floor covering.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. AWRC Corporation; AMERI-SHIELD Shield-Sheen WB 20.
    b. BASF Corporation-Construction Systems; MasterKure CC 200 WB (Pre-2014: Kure-N-Seal W).
    c. ChemMasters, Inc; Polyseal WB.
    d. Dayton Superior; Cure & Seal 1315 J22 WB.
    e. Euclid Chemical Company (The); an RPM company; Diamond Clear VOX.
    f. L&M Construction Chemicals, Inc; Dress & Seal WB.
    g. Lambert Corporation; Glazecote Sealer-20.
    h. Metalcrete Industries; Metcure 0800.
    i. Nox-Crete Products Group; Cure & Seal 200E or Cure & Seal 250 E.
    j. SpecChem, LLC; Cure & Seal WB 25.
    k. Vexcon Chemicals Inc.; Starseal 0800.
    l. W.R. Meadows, Inc; Vocomp-20.

## 2.12 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork.

B. Semirigid Joint Filler: Two-component, semirigid, 100 percent solids, epoxy resin with a Type A shore durometer hardness of 80 or aromatic polyurea with a Type A shore durometer hardness range of 90 to 95 according to ASTM D 2240.

C. Bonding Agent: ASTM C 1059/C 1059M, Type II, nonredispersible, acrylic emulsion or styrene butadiene.

D. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements, and as follows:

1. Types I and II at nonload bearing conditions, Types IV and V at load bearing conditions, for bonding hardened or freshly mixed concrete to hardened concrete.

E. Reglets: Fabricate reglets of not less than 0.022-inch- thick, galvanized-steel sheet. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.

F. Dovetail Anchor Slots: Hot-dip galvanized-steel sheet, not less than 0.034 inch thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.

## 2.13 REPAIR MATERIALS

A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.

1. Cement Binder: ASTM C 150/C 150M, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by underlayment manufacturer.
4. Compressive Strength: Not less than 4100 psi at 28 days when tested according to ASTM C 109/C 109M.

B. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/4 inch and that can be filled in over a scarified surface to match adjacent floor elevations.

1. Cement Binder: ASTM C 150/C 150M, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by topping manufacturer.
4. Compressive Strength: Not less than 5000 psi at 28 days when tested according to ASTM C 109/C 109M.

## 2.14 CONCRETE MIXTURES, GENERAL

A. Prepare design mixtures for each type and strength of concrete as indicated on drawings, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.

1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.

B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:

1. Fly Ash: 25 percent.
2. Combined Fly Ash and Pozzolan: 25 percent.
3. Slag Cement: 50 percent.
4. Combined Fly Ash or Pozzolan and Slag Cement: 50 percent portland cement minimum, with fly ash or pozzolan not exceeding 25 percent.
5. Silica Fume: 10 percent.
6. Combined Fly Ash, Pozzolans, and Silica Fume: 35 percent with fly ash or pozzolans not exceeding 25 percent and silica fume not exceeding 10 percent.
7. Combined Fly Ash or Pozzolans, Slag Cement, and Silica Fume: 50 percent with fly ash or pozzolans not exceeding 25 percent and silica fume not exceeding 10 percent.

C. Limit water-soluble, chloride-ion content in hardened concrete to the following by percent by weight of cement:

1. Prestressed and Post-Tensioned concrete: 0.06
2. Reinforced concrete exposed to chloride: 0.15
3. Reinforced concrete that is not dry or protected from moisture: 0.30
4. Reinforced concrete that is dry or protected from moisture: 1.00

D. Admixtures: Use admixtures according to manufacturer's written instructions.

1. Use water-reducing, high-range water-reducing, or plasticizing admixture in concrete, as required, for placement and workability.

2. Use water-reducing and -retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
3. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a w/c ratio below 0.50.
4. Use corrosion-inhibiting admixture in concrete mixtures where indicated.

E. Color Pigment: Add color pigment to concrete mixture according to manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.

## 2.15 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

## 2.16 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M, and furnish batch ticket information.

1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Mix concrete materials in appropriate drum-type batch machine mixer.

1. For mixer capacity of 1 cu. yd. or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.
2. For mixer capacity larger than 1 cu. yd., increase mixing time by 15 seconds for each additional 1 cu. yd..
3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.

## PART 3 - EXECUTION

### 3.1 FORMWORK INSTALLATION

A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.

B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.

C. Limit concrete surface irregularities, designated by ACI 347 as abrupt or gradual, as follows:

1. Class A, 1/8 inch for smooth-formed finished surfaces.
2. Class B, 1/4 inch for rough-formed finished surfaces.

D. Construct forms tight enough to prevent loss of concrete mortar.

E. Construct forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast-concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.

1. Install keyways, reglets, recesses, and the like, for easy removal.
2. Do not use rust-stained steel form-facing material.

F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.

G. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.

H. Chamfer exterior corners and edges of permanently exposed concrete, unless otherwise noted.

I. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.

J. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

K. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

L. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

## 3.2 EMBEDDED ITEM INSTALLATION

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

1. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC 303.
2. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.
3. Install dovetail anchor slots in concrete structures as indicated.

## 3.3 REMOVING AND REUSING FORMS

A. General: Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F for 24 hours after placing concrete. Concrete has to be hard enough to not be damaged by form-removal operations, and curing and protection operations need to be maintained.

1. Leave formwork for beam soffits, joists, slabs, and other structural elements that support weight of concrete in place until concrete has achieved at least 70 percent of its 28-day design compressive strength.
2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.

B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material are not acceptable for exposed surfaces. Apply new form-release agent.

C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

## 3.4 SHORING AND RESHORING INSTALLATION

A. Comply with ACI 318 and ACI 301 for design, installation, and removal of shoring and reshoring.

1. Do not remove shoring or reshoring until measurement of slab tolerances is complete.

B. In multistory construction, extend shoring or reshoring over a sufficient number of stories to distribute loads in such a manner that no floor or member will be excessively loaded or will induce tensile stress in concrete members without sufficient steel reinforcement.

C. Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.

## 3.5 VAPOR-RETARDER INSTALLATION

A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder according to ASTM E 1643 and manufacturer's written instructions.

1. Lap joints 6 inches and seal with manufacturer's recommended tape.

B. Bituminous Vapor Retarders: Place, protect, and repair bituminous vapor retarder according to manufacturer's written instructions.

## 3.6 STEEL REINFORCEMENT INSTALLATION

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that reduce bond to concrete.

C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.

1. Weld reinforcing bars according to AWS D1.4/D 1.4M, where indicated.

D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

E. Install welded-wire reinforcement in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.

F. Epoxy-Coated Reinforcement: Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D 3963/D 3963M. Use epoxy-coated steel wire ties to fasten epoxy-coated steel reinforcement.

G. Zinc-Coated Reinforcement: Repair cut and damaged zinc coatings with zinc repair material according to ASTM A 780/A 780M. Use galvanized-steel wire ties to fasten zinc-coated steel reinforcement.

## 3.7 JOINTS

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.

1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.
2. Form keyed joints as indicated. Embed keys at least 1-1/2 inches into concrete.
3. Locate joints for beams, slabs, joists, and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
4. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
5. Space vertical joints in walls as indicated. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
6. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
7. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows:

1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.

2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- wide joints into concrete when cutting action does not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.

D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.

1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface unless otherwise indicated.
2. Terminate full-width joint-filler strips not less than 1/2 inch or more than 1 inch below finished concrete surface where joint sealants, specified in Section 079200 "Joint Sealants," are indicated.
3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

E. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint.

## 3.8 WATERSTOP INSTALLATION

A. Flexible Waterstops: Install in construction joints and at other joints indicated to form a continuous diaphragm. Install in longest lengths practicable. Support and protect exposed waterstops during progress of the Work. Field fabricate joints in waterstops according to manufacturer's written instructions.

B. Self-Expanding Strip Waterstops: Install in construction joints and at other locations indicated, according to manufacturer's written instructions, adhesive bonding, mechanically fastening, and firmly pressing into place. Install in longest lengths practicable.

## 3.9 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections are completed.

B. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Architect.

C. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.

1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.

D. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete is placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.

1. Deposit concrete in horizontal layers of depth not to exceed formwork design pressures and in a manner to avoid inclined construction joints.
2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.

E. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.

1. Consolidate concrete during placement operations, so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
2. Maintain reinforcement in position on chairs during concrete placement.
3. Screed slab surfaces with a straightedge and strike off to correct elevations.
4. Slope surfaces uniformly to drains where required.
5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.

## 3.10 FINISHING FORMED SURFACES

A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

1. Apply to concrete surfaces not exposed to public view.

B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

1. Apply to concrete surfaces exposed to public view, to receive a rubbed finish, or to be covered with a coating or covering material applied directly to concrete.

C. Rubbed Finish: Apply the following to smooth-formed-finished as-cast concrete where indicated:

1. Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.
2. Grout-Cleaned Finish: Wet concrete surfaces and apply grout of a consistency of thick paint to coat surfaces and fill small holes. Mix 1 part portland cement to 1-1/2 parts fine sand with a 1:1 mixture of bonding admixture and water. Add white portland cement in amounts determined by trial patches, so color of dry grout matches adjacent surfaces. Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap and keep surface damp by fog spray for at least 36 hours.
3. Cork-Floated Finish: Wet concrete surfaces and apply a stiff grout. Mix 1 part portland cement and 1 part fine sand with a 1:1 mixture of bonding agent and water. Add white portland cement in amounts determined by trial patches, so color of dry grout matches adjacent surfaces. Compress grout into voids by grinding surface. In a swirling motion, finish surface with a cork float.

D. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

## 3.11 FINISHING FLOORS AND SLABS

A. General: Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff brushes, brooms, or rakes to produce a profile amplitude of 1/4 inch in one direction.

1. Apply scratch finish to surfaces to receive concrete floor toppings or mortar setting beds for bonded cementitious floor finishes.

C. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power-driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture.

1. Apply float finish to surfaces to receive trowel finish or to be covered with fluid-applied or sheet waterproofing, built-up or membrane roofing, or sand-bed terrazzo.

D. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.

1. Apply a trowel finish to surfaces exposed to view or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin-film-finish coating system.
2. Finish surfaces to the following tolerances, according to ASTM E 1155, for a randomly trafficked floor surface:

    a. Specified overall values of flatness, F(F) 25; and of levelness, F(L) 20; with minimum local values of flatness, F(F) 17; and of levelness, F(L) 15.

3. Finish and measure surface, so gap at any point between concrete surface and an unleveled, freestanding, 10-ft.- long straightedge resting on two high spots and placed anywhere on the surface does not exceed 1/4 inch.

E. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces where ceramic or quarry tile is to be installed by either thickset or thinset method. While concrete is still plastic, slightly scarify surface with a fine broom.

1. Comply with flatness and levelness tolerances for trowel-finished floor surfaces.

F. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, ramps, and elsewhere as indicated.

1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Architect before application.

G. Slip-Resistive Finish: Before final floating, apply slip-resistive aggregate finish where indicated and to concrete stair treads, platforms, and ramps. Apply according to manufacturer's written instructions and as follows:

1. Uniformly spread 25 lb/100 sq. ft. of dampened slip-resistive aggregate over surface in one or two applications. Tamp aggregate flush with surface, but do not force below surface.
2. After broadcasting and tamping, apply float finish.
3. After curing, lightly work surface with a steel wire brush or an abrasive stone and water to expose slip-resistive aggregate.

H. Dry-Shake Floor Hardener Finish: After initial floating, apply dry-shake floor hardener to surfaces according to manufacturer's written instructions and as follows:

1. Uniformly apply dry-shake floor hardener at a rate of 100 lb/100 sq. ft. unless greater amount is recommended by manufacturer.
2. Uniformly distribute approximately two-thirds of dry-shake floor hardener over surface by hand or with mechanical spreader, and embed by power floating. Follow power floating with a second dry-shake floor hardener application, uniformly distributing remainder of material, and embed by power floating.
3. After final floating, apply a trowel finish. Cure concrete with curing compound recommended by dry-shake floor hardener manufacturer and apply immediately after final finishing.

## 3.12 MISCELLANEOUS CONCRETE ITEM INSTALLATION

A. Filling In: Fill in holes and openings left in concrete structures after work of other trades is in place unless otherwise indicated. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.

B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

C. Equipment Bases and Foundations:

1. Coordinate sizes and locations of concrete bases with actual equipment provided.
2. Construct concrete bases 4 inches high unless otherwise indicated, and extend base not less than 6 inches in each direction beyond the maximum dimensions of supported equipment unless otherwise indicated or unless required for seismic anchor support.
3. Minimum Compressive Strength: 3000 psi at 28 days.
4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete substrate.
6. Prior to pouring concrete, place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
7. Cast anchor-bolt insert into bases. Install anchor bolts to elevations required for proper attachment to supported equipment.

D. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items. Cast-in inserts and accessories as shown on Drawings. Screed, tamp, and trowel finish concrete surfaces.

## 3.13 CONCRETE PROTECTING AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.

B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for remainder of curing period.

D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.

E. Cure concrete according to ACI 308.1, by one or a combination of the following methods:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:

    a. Water.
    b. Continuous water-fog spray.
    c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period, using cover material and waterproof tape.

    a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
    b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.

c. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer certifies does not interfere with bonding of floor covering used on Project.

3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

a. Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer unless manufacturer certifies curing compound does not interfere with bonding of floor covering used on Project.

4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

## 3.14 LIQUID FLOOR TREATMENT APPLICATION

A. Penetrating Liquid Floor Treatment: Prepare, apply, and finish penetrating liquid floor treatment according to manufacturer's written instructions.

1. Remove curing compounds, sealers, oil, dirt, laitance, and other contaminants and complete surface repairs.
2. Do not apply to concrete that is less than 28 days' old.
3. Apply liquid until surface is saturated, scrubbing into surface until a gel forms; rewet; and repeat brooming or scrubbing. Rinse with water; remove excess material until surface is dry. Apply a second coat in a similar manner if surface is rough or porous.

B. Sealing Coat: Uniformly apply a continuous sealing coat of curing and sealing compound to hardened concrete by power spray or roller according to manufacturer's written instructions.

## 3.15 JOINT FILLING

A. Prepare, clean, and install joint filler according to manufacturer's written instructions.

1. Defer joint filling until concrete has aged at least six month(s). Do not fill joints until construction traffic has permanently ceased.

B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joints clean and dry.

C. Install semirigid joint filler full depth in saw-cut joints and at least 2 inches deep in formed joints. Overfill joint and trim joint filler flush with top of joint after hardening.

## 3.16 CONCRETE SURFACE REPAIRS

A. Defective Concrete: Repair and patch defective areas when approved by Architect. Remove and replace concrete that cannot be repaired and patched to Architect's approval.

B. Patching Mortar: Mix dry-pack patching mortar, consisting of 1 part portland cement to 2-1/2 parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.

C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.

1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension to solid concrete. Limit cut depth to 3/4 inch. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar matches surrounding color. Patch a test area 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. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Architect.

D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.

1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
2. After concrete has cured at least 14 days, correct high areas by grinding.

3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
4. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.
5. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
6. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least a 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mixture as original concrete, except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
7. Repair random cracks and single holes 1 inch or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.

E. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.

F. Repair materials and installation not specified above may be used, subject to Architect's approval.

## 3.17 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a special inspector and qualified testing and inspecting agency to perform field tests and inspections and prepare test reports in accordance with IBC – Chapter 17 and applicable referenced standards.

B. Inspections:

1. Steel reinforcement placement.
2. Steel reinforcement welding.
3. Headed bolts and studs.
4. Verification of use of required design mixture.

5. Concrete placement, including conveying and depositing.
6. Curing procedures and maintenance of curing temperature.
7. Verification of concrete strength before removal of shores and forms from beams and slabs.

C. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172/C 172M shall be performed according to the following requirements:

1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd., but less than 25 cu. yd., plus one set for each additional 50 cu. yd. or fraction thereof.
2. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. or fraction thereof of each concrete mixture placed each day.

    a. When frequency of testing provides fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

3. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
4. Air Content: ASTM C 231/C 231M, pressure method, for normal-weight concrete; ASTM C 173/C 173M, volumetric method, for structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
5. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F and below or 80 deg F and above, and one test for each composite sample.
6. Unit Weight: ASTM C 567/C 567M, fresh unit weight of structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
7. Compression Test Specimens: ASTM C 31/C 31M.

    a. Cast and laboratory cure a minimum of three sets of two standard cylinder specimens for each composite sample.
    b. Cast and field cure a minimum of three sets of two standard cylinder specimens for each composite sample.

8. Compressive-Strength Tests: ASTM C 39/C 39M; test one set of two laboratory-cured specimens at 7 days and one set of two specimens at 28 days. If 28 day tests do not meet specified compressive-strength requirements, hold remaining set of two laboratory-cured specimens for 56 day tests.

    a. Test one set of two field-cured specimens at 7 days and one set of two specimens at 28 days. If 28 day tests do not meet specified compressive-

strength requirements, hold remaining set of two field-cured specimens for 56 day tests.

b. A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.

9. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
10. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
11. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for 7-, 28-, and 56-day tests.
12. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect as a correlation guide, but will not be used as sole basis for approval or rejection of concrete.
13. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42/C 42M or by other methods as directed by Architect.
14. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
15. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

D. Measure floor and slab flatness and levelness according to ASTM E 1155 within 24 hours of finishing.

## 3.18 PROTECTION OF LIQUID FLOOR TREATMENTS

A. Protect liquid floor treatment from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by liquid floor treatments installer.

END OF SECTION 03300

# SECTION 042200 - CONCRETE UNIT MASONRY

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:

1. Concrete masonry units.
2. Mortar and grout.
3. Steel reinforcing bars.
4. Masonry-joint reinforcement.
5. Embedded flashing.
6. Miscellaneous masonry accessories.
7. Masonry-cell fill.

B. Products Installed but not Furnished under This Section:

1. Cast-stone trim in concrete unit masonry.

### 1.3 DEFINITIONS

A. CMU(s): Concrete masonry unit(s).

B. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

### 1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

### 1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For the following:

1. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes.
2. Reinforcing Steel: Detail bending, lap lengths, and placement of unit masonry reinforcing bars. Comply with ACI 315.
3. Fabricated Flashing: Detail corner units, end-dam units, and other special applications.

## 1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Material Certificates: For each type and size of the following:

1. Masonry units.

a. Include data on material properties material & test reports substantiating compliance with requirements.

2. Cementitious materials. Include name of manufacturer, brand name, and type.
3. Mortar admixtures.
4. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
5. Grout mixes. Include description of type and proportions of ingredients.
6. Reinforcing bars.
7. Joint reinforcement.
8. Anchors, ties, and metal accessories.

C. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.

D. Statement of Compressive Strength of Masonry: For each combination of masonry unit type and mortar type, provide statement of average net-area compressive strength of masonry units, mortar type, and resulting net-area compressive strength of masonry determined according to TMS 602/ACI 530.1/ASCE 6.

## 1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM C 1093 for testing indicated.

## 1.8 DELIVERY, STORAGE, AND HANDLING

A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.

B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

D. Deliver preblended, dry mortar mix in moisture-resistant containers. Store preblended, dry mortar mix in delivery containers on elevated platforms in a dry location or in covered weatherproof dispensing silos.

E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.9 FIELD CONDITIONS

A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.

1. Extend cover a minimum of 24 inches down both sides of walls, and hold cover securely in place.

B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least three days after building masonry walls or columns.

C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.

1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
2. Protect sills, ledges, and projections from mortar droppings.
3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.

D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.

1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and higher and will remain so until masonry has dried, but not less than seven days after completing cleaning.

E. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from single source from single manufacturer for each product required.

B. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from single manufacturer for each cementitious component and from single source or producer for each aggregate.

### 2.2 PERFORMANCE REQUIREMENTS

A. Provide structural unit masonry that develops indicated net-area compressive strengths at 28 days.

1. Determine net-area compressive strength of masonry from average net-area compressive strengths of masonry units and mortar types (unit-strength method) according to TMS 602/ACI 530.1/ASCE 6.
2. Determine net-area compressive strength of masonry by testing masonry prisms according to ASTM C 1314.

### 2.3 UNIT MASONRY, GENERAL

A. Masonry Standard: Comply with TMS 602/ACI 530.1/ASCE 6 except as modified by requirements in the Contract Documents.

B. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated. Do not use units where such defects are exposed in the completed Work.

C. Fire-Resistance Ratings: Comply with requirements for fire-resistance-rated assembly designs indicated.

1. Where fire-resistance-rated construction is indicated, units shall be listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction.

## 2.4 CONCRETE MASONRY UNITS

A. Shapes: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.

1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
2. Provide square-edged units for outside corners unless otherwise indicated.

B. CMUs: ASTM C 90.

1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 2800 psi.
2. Density Classification: Normal weight.
3. Size (Width): Manufactured to dimensions 3/8 inch less-than-nominal dimensions.
4. Exposed Faces: Provide color and texture matching the range represented by Architect's sample.
5. Faces to Receive Plaster: Where units are indicated to receive a direct application of plaster, provide textured-face units made with gap-graded aggregates.

## 2.5 MORTAR AND GROUT MATERIALS

A. Portland Cement: ASTM C 150/C 150M, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.

1. Alkali content shall not be more than 0.1 percent when tested according to ASTM C 114.

B. Hydrated Lime: ASTM C 207, Type S.

C. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.

D. Masonry Cement: ASTM C 91/C 91M.

E. Mortar Cement: ASTM C 1329/C 1329M.

F. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C 979/C 979M. Use only pigments with a record of satisfactory performance in masonry mortar.

G. Aggregate for Grout: ASTM C 404.

H. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C 494/C 494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.

I. Water: Potable.

## 2.6 REINFORCEMENT

A. Uncoated Steel Reinforcing Bars: ASTM A 615/A 615M or ASTM A 996/A 996M, Grade 60.

B. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells and to hold reinforcing bars in center of cells. Units are formed from 0.148-inch steel wire, hot-dip galvanized after fabrication. Provide units designed for number of bars indicated.

C. Masonry-Joint Reinforcement, General: Ladder type complying with ASTM A 951/A 951M.

1. Interior Walls: Hot-dip galvanized carbon steel.
2. Exterior Walls: Hot-dip galvanized carbon steel.
3. Wire Size for Side Rods: 0.148-inch diameter.
4. Wire Size for Cross Rods: 0.148-inch diameter.
5. Spacing of Cross Rods: Not more than 16 inches o.c.
6. Provide in lengths of not less than 10 feet.

## 2.7 TIES AND ANCHORS

A. General: Ties and anchors shall extend at least 1-1/2 inches into masonry but with at least a 5/8-inch cover on outside face.

B. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated:

1. Mill-Galvanized, Carbon-Steel Wire: ASTM A 82/A 82M, with ASTM A 641/A 641M, Class 1 coating.
2. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A 82/A 82M, with ASTM A 153/A 153M, Class B-2 coating.
3. Galvanized-Steel Sheet: ASTM A 653/A 653M, Commercial Steel, G60 zinc coating.
4. Steel Sheet, Galvanized after Fabrication: ASTM A 1008/A 1008M, Commercial Steel, with ASTM A 153/A 153M, Class B coating.
5. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

C. Partition Top Anchors: 0.105-inch-thick metal plate with a 3/8-inch-diameter metal rod 6 inches long welded to plate and with closed-end plastic tube fitted over rod that allows rod to move in and out of tube.

## 2.8 MISCELLANEOUS MASONRY ACCESSORIES

A. Compressible Filler: Premolded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neopreneurethaneorPVC.

B. Preformed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying with ASTM D 2000, Designation M2AA-805 orPVC, complying with ASTM D 2287, Type PVC-65406 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.

C. Bond-Breaker Strips: Asphalt-saturated felt complying with ASTM D 226/D 226M, Type I (No. 15 asphalt felt).

## 2.9 MORTAR AND GROUT MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated.

1. Do not use calcium chloride in mortar or grout.

B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

C. Mortar for Unit Masonry: Comply with ASTM C 270, Proportion Specification. Provide the following types of mortar for applications stated unless another type is indicated.

1. For masonry below grade or in contact with earth, use Type S.
2. For reinforced masonry, use Type S.
3. For mortar parge coats, use Type S.
4. For exterior, above-grade, load-bearing and nonload-bearing walls and parapet walls; for interior load-bearing walls; for interior nonload-bearing partitions; and for other applications where another type is not indicated, use Type N.
5. For interior nonload-bearing partitions, Type O may be used instead of Type N.

D. Grout for Unit Masonry: Comply with ASTM C 476.

1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with TMS 602/ACI 530.1/ASCE 6 for dimensions of grout spaces and pour height.
2. Proportion grout in accordance with ASTM C 476, paragraph 4.2.2 for specified 28-day compressive strength indicated, but not less than 2000 psi.
3. Provide grout with a slump of 8 to 11 inches as measured according to ASTM C 143/C 143M.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
2. Verify that foundations are within tolerances specified.
3. Verify that reinforcing dowels are properly placed.
4. Verify that substrates are free of substances that would impair mortar bond.

B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION, GENERAL

A. Build chases and recesses to accommodate items specified in this and other Sections.

B. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match construction immediately adjacent to opening.

C. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

### 3.3 TOLERANCES

A. Dimensions and Locations of Elements:

1. For dimensions in cross section or elevation, do not vary by more than plus 1/2 inch or minus 1/4 inch.
2. For location of elements in plan, do not vary from that indicated by more than plus or minus 1/2 inch.
3. For location of elements in elevation, do not vary from that indicated by more than plus or minus 1/4 inch in a story height or 1/2 inch total.

B. Lines and Levels:

1. For bed joints and top surfaces of bearing walls, do not vary from level by more than 1/4 inch in 10 feet, or 1/2-inch maximum.
2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2-inch maximum.
3. For vertical lines and surfaces do not vary from plumb by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2-inch maximum.
4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2-inch maximum.
5. For lines and surfaces, do not vary from straight by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2-inch maximum.
6. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet, or 1/2-inch maximum.
7. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than 1/16 inch.

C. Joints:

1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch.
2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch.
3. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch or minus 1/4 inch.
4. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch.

## 3.4 LAYING MASONRY WALLS

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.

B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less-than-nominal 4-inch horizontal face dimensions at corners or jambs.

C. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 4 inches. Bond and interlock each course of each wythe at corners. Do not use units with less-than-nominal 4-inch horizontal face dimensions at corners or jambs.

D. Stopping and Resuming Work: Stop work by stepping back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.

E. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.

F. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.

G. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below, and rod mortar or grout into core.

H. Fill cores in hollow CMUs with grout 24 inches under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.

I. Build nonload-bearing interior partitions full height of story to underside of solid floor or roof structure above unless otherwise indicated.

1. Install compressible filler in joint between top of partition and underside of structure above.
2. Wedge nonload-bearing partitions against structure above with small pieces of tile, slate, or metal. Fill joint with mortar after dead-load deflection of structure above approaches final position.
3. At fire-rated partitions, treat joint between top of partition and underside of structure above to comply with Section 078443 "Joint Firestopping."

## 3.5 MORTAR BEDDING AND JOINTING

A. Lay hollow CMUs as follows:

1. Bed face shells in mortar and make head joints of depth equal to bed joints.
2. Bed webs in mortar in all courses of piers, columns, and pilasters.
3. Bed webs in mortar in grouted masonry, including starting course on footings.
4. Fully bed entire units, including areas under cells, at starting course on footings where cells are not grouted.

B. Lay solid CMUs with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

C. Set cast-stone trim units in full bed of mortar with full vertical joints. Fill dowel, anchor, and similar holes.

1. Clean soiled surfaces with fiber brush and soap powder and rinse thoroughly with clear water.
2. Wet joint surfaces thoroughly before applying mortar.
3. Rake out mortar joints for pointing with sealant.

D. Rake out mortar joints at pre-faced CMUs to a uniform depth of 1/4 inch and point with epoxy mortar to comply with epoxy-mortar manufacturer's written instructions.

E. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

F. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint) unless otherwise indicated.

G. Cut joints flush where indicated to receive waterproofing unless otherwise indicated.

## 3.6 MASONRY-JOINT REINFORCEMENT

A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcement a minimum of 6 inches.

1. Space reinforcement not more than 16 inches o.c.
2. Space reinforcement not more than 8 inches o.c. in foundation walls and parapet walls.
3. Provide reinforcement not more than 8 inches above and below wall openings and extending 12 inches beyond openings in addition to continuous reinforcement.

B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.

C. Provide continuity at wall intersections by using prefabricated T-shaped units.

D. Provide continuity at corners by using prefabricated L-shaped units.

E. Cut and bend reinforcing units as directed by manufacturer for continuity at corners, returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

## 3.7 CONTROL AND EXPANSION JOINTS

A. General: Install control- and expansion-joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.

B. Form control joints in concrete masonry using one of the following methods:

1. Fit bond-breaker strips into hollow contour in ends of CMUs on one side of control joint. Fill resultant core with grout, and rake out joints in exposed faces for application of sealant.
2. Install preformed control-joint gaskets designed to fit standard sash block.
3. Install interlocking units designed for control joints. Install bond-breaker strips at joint. Keep head joints free and clear of mortar, or rake out joint for application of sealant.
4. Install temporary foam-plastic filler in head joints, and remove filler when unit masonry is complete for application of sealant.

## 3.8 LINTELS

A. Provide minimum bearing of 8 inches at each jamb unless otherwise indicated.

## 3.9 FLASHING

A. General: Install embedded flashing at ledges and other obstructions to downward flow of water in wall where indicated.

B. Install flashing as follows unless otherwise indicated:

1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer.
2. At lintels, extend flashing a minimum of 6 inches into masonry at each end. At heads and sills, extend flashing 6 inches at ends and turn up not less than 2 inches to form end dams.
3. Interlock end joints of ribbed sheet metal flashing by overlapping ribs not less than 1-1/2 inches or as recommended by flashing manufacturer, and seal lap with elastomeric sealant complying with requirements in Section 079200 "Joint Sealants" for application indicated.
4. Install metal drip edges and sealant stops with ribbed sheet metal flashing by interlocking hemmed edges to form hooked seam. Seal seam with elastomeric sealant complying with requirements in Section 079200 "Joint Sealants" for application indicated.

5. Install metal drip edges beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch back from outside face of wall, and adhere flexible flashing to top of metal drip edge.
6. Install metal flashing termination beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch back from outside face of wall, and adhere flexible flashing to top of metal flashing termination.
7. Cut flexible flashing off flush with face of wall after masonry wall construction is completed.

C. Install single-wythe CMU flashing system in bed joints of CMU walls where indicated to comply with manufacturer's written instructions. Install CMU cell pans with upturned edges located below face shells and webs of CMUs above and with weep spouts aligned with face of wall. Install CMU web covers so that they cover upturned edges of CMU cell pans at CMU webs and extend from face shell to face shell.

D. Install reglets and nailers for flashing and other related construction where they are shown to be built into masonry.

## 3.10 REINFORCED UNIT MASONRY INSTALLATION

A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.

1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other loads that may be placed on them during construction.

B. Placing Reinforcement: Comply with requirements in TMS 602/ACI 530.1/ASCE 6.

C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.

1. Comply with requirements in TMS 602/ACI 530.1/ASCE 6 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
2. Limit height of vertical grout pours to not more than 60 inches.

## 3.11 FIELD QUALITY CONTROL

A. Testing and Inspecting: Owner will engage special inspectors to perform tests and inspections and prepare reports. Allow inspectors access to scaffolding and work areas

as needed to perform tests and inspections. Retesting of materials that fail to comply with specified requirements shall be done at Contractor's expense.

B. Inspections: Special inspections according to Level B in TMS 402/ACI 530/ASCE 5.

1. Begin masonry construction only after inspectors have verified proportions of site-prepared mortar.
2. Place grout only after inspectors have verified compliance of grout spaces and of grades, sizes, and locations of reinforcement.
3. Place grout only after inspectors have verified proportions of site-prepared grout.

C. Testing Prior to Construction: One set of tests.

D. Concrete Masonry Unit Test: For each type of unit provided, according to ASTM C 140 for compressive strength.

E. Mortar Aggregate Ratio Test (Proportion Specification): For each mix provided, according to ASTM C 780.

F. Prism Test: For each type of construction provided, according to ASTM C 1314 at 7 days and at 28 days.

## 3.12 PARGING

A. Parge exterior faces of below-grade masonry walls, where indicated, in two uniform coats to a total thickness of 3/4 inch. Dampen wall before applying first coat, and scarify first coat to ensure full bond to subsequent coat.

B. Use a steel-trowel finish to produce a smooth, flat, dense surface with a maximum surface variation of 1/8 inch per foot. Form a wash at top of parging and a cove at bottom.

C. Damp-cure parging for at least 24 hours and protect parging until cured.

## 3.13 REPAIRING, POINTING, AND CLEANING

A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.

B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.

C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:

1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.
3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
5. Clean concrete masonry by applicable cleaning methods indicated in NCMA TEK 8-4A.

## 3.14 MASONRY WASTE DISPOSAL

A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.

B. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.

1. Crush masonry waste to less than 4 inches in each dimension.
2. Mix masonry waste with at least two parts of specified fill material for each part of masonry waste. Fill material is specified in Section 312000 "Earth Moving."
3. Do not dispose of masonry waste as fill within 18 inches of finished grade.

C. Masonry Waste Recycling: Return broken CMUs not used as fill to manufacturer for recycling.

D. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above or recycled, and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION 04220

# SECTION 042613 - MASONRY VENEER

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Clay face brick.

B. Products Installed but Not Furnished under This Section:

1. Steel lintels in masonry veneer.
2. Steel shelf angles for supporting masonry veneer.

### 1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples for Verification: For each type and color of brick and colored mortar.

### 1.3 INFORMATIONAL SUBMITTALS

A. Material Certificates: For each type and size of product.

### 1.4 QUALITY ASSURANCE

A. Sample Panels: As indicated in the Architectural drawings.

### 1.5 FIELD CONDITIONS

A. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.

1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and higher and will remain so until masonry has dried, but not less than seven days after completing cleaning.

B. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.

PART 2 - PRODUCTS

## 2.1 UNIT MASONRY, GENERAL

A. Masonry Standard: Comply with TMS 602/ACI 530.1/ASCE 6, except as modified by requirements in the Contract Documents.

B. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated. Do not use units where such defects will be exposed in the completed Work.

## 2.2 BRICK

A. Shapes: Provide shapes indicated and as follows, with exposed surfaces matching finish and color of exposed faces of adjacent units:

1. For ends of sills and caps and for similar applications that would otherwise expose unfinished brick surfaces, provide units without cores or frogs and with exposed surfaces finished.
2. Provide special shapes for applications where shapes produced by sawing would result in sawed surfaces being exposed to view.

B. Clay Face Brick: Facing brick complying with ASTM C216.

1. Brick 1 = Pine Hall Brick “Burnt Cedar”. Brick 2 = Pine Hall Brick “Old Colony”
2. Grade SW.
3. Type FBS.
4. Initial Rate of Absorption: Less than 30 g/30 sq. in. per minute when tested according to ASTM C67.
5. Efflorescence: Provide brick that has been tested according to ASTM C67 and is rated "not effloresced."
6. Surface Coating: Brick with colors or textures produced by application of coatings shall withstand 50 cycles of freezing and thawing according to ASTM C67 with no observable difference in the applied finish when viewed from 10 feet.
7. Size: Modular.

## 2.3 MORTAR MATERIALS

A. Colored Cement Products: Packaged blend made from portland cement and hydrated lime masonry cement or mortar cement and mortar pigments, all complying with specified requirements, and containing no other ingredients.

1. Workrite Colored Masonry Cement: WR 2208

B. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C494/C494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.

C. Water-Repellent Admixture: Liquid water-repellent mortar admixture intended for use with concrete bricks containing integral water repellent from same manufacturer.

D. Water: Potable.

2.4 TIES AND ANCHORS – See structural drawings.

2.5 EMBEDDED FLASHING MATERIALS

A. Metal Flashing: Provide metal flashing complying with SMACNA's "Architectural Sheet Metal Manual" and as follows:

1. Stainless Steel: ASTM A240/A240M or ASTM A666, Type 304, 0.016 inch thick.
2. Fabricate continuous flashings in sections 96 inches long minimum, but not exceeding 12 feet. Provide splice plates at joints of formed, smooth metal flashing.
3. Fabricate metal drip edges from stainless steel. Extend at least 3 inches into wall and 1/2 inch out from wall, with outer edge bent down 30 degrees and hemmed.
4. Fabricate metal sealant stops from stainless steel. Extend at least 3 inches into wall and out to exterior face of wall. At exterior face of wall, bend metal back on itself for 3/4 inch and down into joint 1/4 inch to form a stop for retaining sealant backer rod.

B. Solder and Sealants for Sheet Metal Flashings: As specified in Section 076200 "Sheet Metal Flashing and Trim."

C. Adhesives, Primers, and Seam Tapes for Flashings: Flashing manufacturer's standard products or products recommended by flashing manufacturer for bonding flashing sheets to each other and to substrates.

2.6 MISCELLANEOUS MASONRY ACCESSORIES

A. Compressible Filler: Premolded filler strips complying with ASTM D1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene urethane or PVC.

B. Weep/Vent Products: Use the following unless otherwise indicated:

1. Cellular Plastic Weep/Vent: One-piece, flexible extrusion made from UV-resistant polypropylene copolymer, full height and width of head joint and depth 1/8 inch less than depth of outer wythe, in color selected from manufacturer's standard.

C. Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.
1. Configuration: Provide one of the following:

a. Strips, full depth of cavity and 10 inches high, with dovetail-shaped notches 7 inches deep that prevent clogging with mortar droppings.

2.7 MASONRY CLEANERS

A. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.

2.8 MORTAR MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated.

1. Do not use calcium chloride in mortar or grout.
2. Use portland cement-lime or masonry cement mortar unless otherwise indicated.
3. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.

B. Colored-Aggregate Mortar: Produce required mortar color by using colored aggregates and natural color or white cement as necessary to produce required mortar color.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

B. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures. Mix units from several pallets or cubes as they are placed.

C. Wetting of Brick: Wet brick before laying if initial rate of absorption exceeds 30 g/30 sq. in. per minute when tested according to ASTM C67. Allow units to absorb water so they are damp but not wet at time of laying.

3.2 TOLERANCES

A. Dimensions and Locations of Elements:

1. For dimensions in cross section or elevation, do not vary by more than plus 1/2 inch or minus 1/4 inch.
2. For location of elements in plan, do not vary from that indicated by more than plus or minus 1/2 inch.
3. For location of elements in elevation, do not vary from that indicated by more than plus or minus 1/4 inch in a story height or 1/2 inch total.

B. Lines and Levels:

1. For bed joints and top surfaces of bearing walls, do not vary from level by more than 1/4 inch in 10 feet, or 1/2 inch maximum.
2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
3. For vertical lines and surfaces, do not vary from plumb by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2 inch maximum.
4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
5. For lines and surfaces, do not vary from straight by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2 inch maximum.

C. Joints:

1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch.
2. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch. Do not vary from adjacent bed-joint and head-joint thicknesses by more than 1/8 inch.

## 3.3 LAYING MASONRY WALLS

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.

B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less-than-nominal 4-inch horizontal face dimensions at corners or jambs.

C. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.

## 3.4 MORTAR BEDDING AND JOINTING

A. Lay masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

B. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

3.5 ANCHORED MASONRY VENEERS – See structural drawings.

3.6 FLASHING, WEEP HOLES, AND VENTS

A. General: Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated.

B. Install flashing as follows unless otherwise indicated:

1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape.
2. At lintels and shelf angles, extend flashing a minimum of 6 inches into masonry at each end. At heads and sills, extend flashing 6 inches at ends and turn up not less than 2 inches to form end dams.

C. Install weep holes in veneers in head joints of first course of masonry immediately above embedded flashing.

1. Use specified weep/vent products to form weep holes.
2. Space weep holes 24 inches o.c. unless otherwise indicated.

D. Place cavity drainage material in airspace behind veneers to comply with configuration requirements for cavity drainage material in "Miscellaneous Masonry Accessories" Article.

3.7 FIELD QUALITY CONTROL

A. Testing and Inspecting: Owner will engage special inspectors to perform tests and inspections and prepare reports. Allow inspectors access to scaffolding and work areas as needed to perform tests and inspections. Retesting of materials that fail to comply with specified requirements shall be done at Contractor's expense.

B. Inspections: Special inspections according to Level B in TMS 402/ACI 530/ASCE 5.

1. Begin masonry construction only after inspectors have verified proportions of site-prepared mortar.

C. Testing Prior to Construction: One set of tests.

D. Clay Masonry Unit Test: For each type of unit provided, according to ASTM C67 for compressive strength.

E. Mortar Aggregate Ratio Test (Proportion Specification): For each mix provided, according to ASTM C780.

## 3.8 REPAIRING, POINTING, AND CLEANING

A. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

B. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:

1. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes.
2. Protect adjacent stone and nonmasonry surfaces from contact with cleaner.
3. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
4. Clean brick by bucket-and-brush hand-cleaning method described in BIA Technical Notes 20.
5. Clean masonry with a proprietary acidic cleaner applied according to manufacturer's written instructions.

## 3.9 MASONRY WASTE DISPOSAL

A. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.

1. Do not dispose of masonry waste as fill within 18 inches of finished grade.

B. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above or recycled, and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION 042613

# SECTION 047200 - CAST STONE MASONRY

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Cast-stone trim.
2. Cast-stone base

### 1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. For cast-stone units, include dimensions and finishes.

B. Samples:

1. For each color and texture of cast stone required.
2. For colored mortar.

### 1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer.

B. Material Test Reports: For each mix required to produce cast stone, based on testing according to ASTM C 1364, including test for resistance to freezing and thawing.

### 1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer of cast-stone units similar to those indicated for this Project, that has sufficient production capacity to manufacture required units, and is a plant certified by the Cast Stone Institute or the Architectural Precast Association.

B. Cast stone shall be fabricated by a plant certified by the APA for Vibra dry-tamp cast stone.

## PART 2 - PRODUCTS

### 2.1 CAST-STONE UNITS

A. Cast-Stone Units: Comply with ASTM C 1364.

1. Units shall be manufactured using the vibrant dry tamp wet-cast method.
2. Units shall be resistant to freezing and thawing as determined by laboratory testing according to ASTM C 666/C 666M, Procedure A, as modified by ASTM C 1364.

B. Fabricate units with sharp arris and accurately reproduced details, with indicated texture on all exposed surfaces unless otherwise indicated.

1. Slope exposed horizontal surfaces 1:12 to drain unless otherwise indicated.
2. Provide raised fillets at backs of sills and at ends indicated to be built into jambs.
3. Provide drips on projecting elements unless otherwise indicated.

C. Cure Units as Follows:

1. Cure units in enclosed, moist curing room at 95 to 100 percent relative humidity and temperature of 100 deg F for 12 hours or 70 deg F for 16 hours.
2. Keep units damp and continue curing to comply with one of the following:

a. No fewer than five days at mean daily temperature of 70 deg F or above.
b. No fewer than six days at mean daily temperature of 60 deg F or above.
c. No fewer than seven days at mean daily temperature of 50 deg F or above.
d. No fewer than eight days at mean daily temperature of 45 deg F or above.

D. Acid etch units after curing to remove cement film from surfaces to be exposed to view.

E. Colors and Textures:

1. Custom Cast Stone Base = “Slate 153”. Size = 1’-4”x 8”
2. Custom Cast Stone Trim = “Natural White. Size varies and is indicated on the Architectural drawings.

## 2.2 ACCESSORIES

A. Anchors: SEE STRUCTURAL ENGINEERING DOCUMENTS.

B. Dowels: SEE STRUCTURAL ENGINEERING DOCUMENTS.

C. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cast-stone manufacturer and expressly approved by cleaner manufacturer for use on cast stone and adjacent masonry materials.

## 2.3 MORTAR

A. Comply with requirements for mortar mixes.

1. For setting mortar, use Type S.
2. For pointing mortar, use Type N.

B. Pigmented Mortar: Use colored cement product. Workrite Colored Masonry Cement. WR2906.

## 2.4 SOURCE QUALITY CONTROL

A. Engage a qualified independent testing agency to sample and test cast-stone units according to ASTM C 1364.

1. Include one test for resistance to freezing and thawing.

# PART 3 - EXECUTION

## 3.1 SETTING CAST STONE IN MORTAR

A. Install cast-stone units to comply with requirements in Section 042000 "Unit Masonry."

B. Set units in full bed of mortar with full head joints unless otherwise indicated.

1. Fill dowel holes and anchor slots with mortar.
2. Fill collar joints solid as units are set.
3. Build concealed flashing into mortar joints as units are set.
4. Keep head joints in copings and between other units with exposed horizontal surfaces open to receive sealant.
5. Keep joints at shelf angles open to receive sealant.

C. Rake out joints for pointing with mortar to depths of not less than 3/4 inch. Rake joints to uniform depths with square bottoms and clean sides. Scrub faces of units to remove excess mortar as joints are raked.

D. Point mortar joints by placing and compacting mortar in layers not greater than 3/8 inch. Compact each layer thoroughly and allow it to become thumbprint hard before applying next layer.

E. Tool exposed joints slightly concave when thumbprint hard. Use a smooth plastic jointer larger than joint thickness.

F. Rake out joints for pointing with sealant to depths of not less than 3/4 inch. Scrub faces of units to remove excess mortar as joints are raked.

G. Provide sealant joints at head joints of copings and other horizontal surfaces; at expansion, control, and pressure-relieving joints; and at locations indicated.

1. Keep joints free of mortar and other rigid materials.
2. Prepare and apply sealant of type and at locations indicated to comply with applicable requirements in Section 079200 "Joint Sealants."

## 3.2 INSTALLATION TOLERANCES

A. Variation from Plumb: Do not exceed 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.

B. Variation from Level: Do not exceed 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.

C. Variation in Joint Width: Do not vary joint thickness more than 1/8 inch in 36 inches or one-fourth of nominal joint width, whichever is less.

D. Variation in Plane between Adjacent Surfaces (Lipping): Do not vary from flush alignment with adjacent units or adjacent surfaces indicated to be flush with units by more than 1/16 inch, except where variation is due to warpage of units within tolerances specified.

## 3.3 ADJUSTING AND CLEANING

A. Remove and replace stained and otherwise damaged units and units not matching approved Samples. Cast stone may be repaired if methods and results are approved by Architect.

B. Replace units in a manner that results in cast stone matching approved Samples, complying with other requirements, and showing no evidence of replacement.

C. In-Progress Cleaning: Clean cast stone as work progresses.

1. Remove mortar fins and smears before tooling joints.
2. Remove excess sealant immediately, including spills, smears, and spatter.

D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed cast stone as follows:

1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
2. Test cleaning methods on sample; leave one sample uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of cast stone.
3. Protect adjacent surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
4. Wet surfaces with water before applying cleaners; remove cleaners promptly by rinsing thoroughly with clear water.
5. Clean cast stone by bucket-and-brush hand-cleaning method described in BIA Technical Notes 20.
6. Clean cast stone with proprietary acidic cleaner applied according to manufacturer's written instructions.

END OF SECTION 047200

# SECTION 051200 - STRUCTURAL STEEL FRAMING

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 REFERENCES

A. Details and fabrication of structural steel shall conform to the following publications.

B. AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

1. AISC M013 Detailing for Steel Construction

2. AISC M016 ASD Manual of Steel Construction

3. AISC S335 Structural Steel Buildings Allowable Stress Design and Plastic Design

C. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

1. ASTM A36/A36M Carbon Structural Steel

2. ASTM A53 Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless

3. ASTM A123/A123M Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

4. ASTM A153/A153M Zinc Coating (Hot-Dip) on Iron and Steel Hardware

5. ASTM A325 Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength

6. ASTM A500 Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes

7. ASTM A563 Carbon and Alloy Steel Nuts

8. ASTM A780 Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings

9. ASTM A992/A992M Steel for Structural Shapes for Use in Building Framing

10. ASTM C827 Change in Height at Early Ages of Cylindrical Specimens from Cementitious Mixtures

11. ASTM C1107 Packaged Dry, Hydraulic-Cement Grout (Nonshrink)

12. ASTM F436Hardened Steel Washers

13. ASTM F844 Washers, Steel, Plain (Flat), Unhardened for General Use

14. ASTM F959Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners

15. ASTM F1554 Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength

D. AMERICAN WELDING SOCIETY, INC. (AWS)

1. AWS D1.1 Structural Welding Code – Steel

E. STEEL STRUCTURES PAINTING COUNCIL (SSPC)

1. SSPC SP 3 Power Tool Cleaning

2. SSPC SP 6 Commercial Blast Cleaning

3. SSPC Paint 25 Red Iron Oxide, Zinc Oxide, Raw Linseed Oil and Alkyd Primer (Without Lead and Chromate Pigments)

4. SSPC PA 1 Shop, Field, and Maintenance Painting

## 1.3 SUMMARY

A. Section Includes:

1. Structural steel.

2. Architecturally exposed structural steel.

3. Grout.

B. Related Sections:

1. Division 1 Section "Quality Requirements" for independent testing agency procedures and administrative requirements.

2. Division 5 Section "Metal Fabrications" for steel lintels or shelf angles not attached to structural-steel frame, miscellaneous steel fabrications, and other metal items not defined as structural steel.

## 1.4 DEFINITIONS

A. Structural Steel: Elements of structural-steel frame, as classified by AISC 303, "Code of Standard Practice for Steel Buildings and Bridges", that support design loads.

B. Architecturally Exposed Structural Steel: Structural steel designated as architecturally exposed structural steel in the Contract Documents.

## 1.5 PERFORMANCE REQUIREMENTS

A. Connections: Provide details of simple shear connections required by the Contract Documents to be selected or completed by structural-steel fabricator to withstand ASD-service loads indicated and comply with other information and restrictions indicated.

1. Select and complete connections using schematic details indicated and AISC's "Manual of Steel Construction, Allowable Stress Design," Part 4.

2. Engineering Responsibility: Fabricator's responsibilities include using a qualified professional engineer to prepare structural analysis data for structural-steel connections.

B. Construction: Combined system of moment frame, braced frame, and shear walls.

C. Moment Connections: Type FR, fully restrained.

## 1.6 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Show fabrication of structural-steel components.

1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.

2. Include embedment drawings.

3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld.

4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts.

5. For structural-steel connections indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

C. Erection Plan.

1. Submit for record purposes. Indicate the sequence of erection, temporary shoring and bracing, and a detailed sequence of welding, including each welding procedure required.

D. Welding certificates.

E. Qualification Data: For testing agency.

F. Mill Test Reports: Signed by manufacturers certifying that the following products comply with requirements:

1. Structural steel including chemical and physical properties.

2. Bolts, nuts, and washers including mechanical properties and chemical analysis.

3. Shear stud connectors.

4. Load indicator washers.

5. Shop primers.

6. Nonshrink grout.

G. Source quality-control test reports.

## 1.7 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced Installer who has completed structural steel work similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.

B. Fabricator Qualifications: Engage a firm experienced in fabricating structural steel similar to that indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to fabricate structural steel without delaying the Work.

1. Fabricator must participate in the AISC Quality Certification Program and be designated an AISC-Certified Plant as follows:

a. Category: Category I, conventional steel structures.

C. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel."

D. Comply with applicable provisions of the following specifications and documents:

1. AISC's "Code of Standard Practice for Steel Buildings and Bridges."

2. AISC's "Seismic Provisions for Structural Steel Buildings" and "Supplement No. 2."

3. AISC's "Specification for Structural Steel Buildings--Allowable Stress Design and Plastic Design."

4. AISC's "Specification for the Design of Steel Hollow Structural Sections."

5. AISC's "Specification for Allowable Stress Design of Single-Angle Members."

6. RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

## 1.8 DELIVERY, STORAGE, AND HANDLING

A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.

1. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.

B. Store fasteners in a protected place in sealed containers with manufacturer's labels intact.

1. Fasteners may be repackaged provided Owner's testing and inspecting agency observes repackaging and seals containers.

2. Clean and relubricate bolts and nuts that become dry or rusty before use.

3. Comply with manufacturers' written recommendations for cleaning and lubricating ASTM F 1852 fasteners and for retesting fasteners after lubrication.

1.9 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

**PART 2 - PRODUCTS**

2.1 STRUCTURAL-STEEL MATERIALS

A. W-Shapes: ASTM A 992/A 992M, Grade 50.

B. Channels, Angles: ASTM A 36.

C. Plate and Bar: ASTM A 36.

D. Cold-Formed Hollow Structural Sections: ASTM A 500, Grade B, structural tubing.

E. Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade B.

1. Weight Class: Standard.

2. Finish: Black**.**

F. Welding Electrodes and Rods: Comply with AWS D1.1 requirements.

2.2 BOLTS, CONNECTORS, AND ANCHORS

A. High-Strength Bolts, Nuts, and Washers: ASTM A 325, Type 1, heavy hex steel structural bolts; ASTM A 563 heavy hex carbon-steel nuts; and ASTM F 436 hardened carbon-steel washers.

1. Finish: Plain**.**

B. Shear Connectors: ASTM A 108, Grades 1015 through 1020, headed-stud type, cold-finished carbon steel; AWS D1.1, Type B.

C. Unheaded Anchor Rods: ASTM F 1554, Grade 36.

1. Configuration: as indicated.

2. Nuts: ASTM A 563 hex carbon steel.

3. Plate Washers: ASTM A 36/A 36M carbon steel.

4. Washers: ASTM F 436 hardened carbon steel.

5. Finish: Plain.

D. Headed Anchor Rods: ASTM F 1554, Grade 36, straight.

1. Nuts: ASTM A 563 hex carbon steel.

2. Plate Washers: ASTM A 36/A 36M carbon steel.

3. Washers: ASTM F 436 hardened carbon steel.

4. Finish: Plain.

E. Load Indicator Washers: ASTM F959.

## 2.3 SHOP PRIMER

A. SSPC Paint 25 epoxy-polyamide, green primer (Form 150) type 1. Primer shall conform to Federal, State, and local VOC regulations. If flash rusting occurs, re-clean the surface prior to application of primer.

## 2.4 GALVANIZING

A. ASTM A123 or ASTM A153, as applicable, unless specified otherwise, galvanize after fabrication where practicable.

## 2.5 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time; capable of developing a minimum compressive strength of 8,000 psi in 28 days.

## 2.6 FABRICATION

A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and AISC's "Specification for Structural Steel Buildings--Allowable Stress Design and Plastic Design."

1. Identify high-strength structural steel according to ASTM A 6/ A 6M and maintain markings until structural steel has been erected.

2. Mark and match-mark materials for field assembly.

3. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.

B. Architecturally Exposed Structural Steel: Comply with fabrication requirements, including tolerance limits, of AISC's "Code of Standard Practice for Steel Buildings and Bridges" for structural steel identified as architecturally exposed structural steel.

1. Fabricate with exposed surfaces smooth, square, and free of surface blemishes including pitting, rust, scale, seam marks, roller marks, rolled trade names, and roughness.

2. Remove blemishes by filling or grinding or by welding and grinding, before cleaning, treating, and shop priming.

C. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.

1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1.

D. Bolt Holes: Cut, drill, or punch standard bolt holes perpendicular to metal surfaces.

E. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.

F. Cleaning: Clean and prepare steel surfaces that are to remain unpainted according to SSPC-SP 6 (U.N.O.)

G. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1 and manufacturer's written instructions.

H. Holes: Provide holes required for securing other work to structural steel and for passage of other work through steel framing members.

1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning.

2. Base-Plate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.

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

## 2.7 SHOP CONNECTIONS

A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.

1. Joint Type: Snug tightened (U.N.O.).

B. Weld Connections: Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work.

1. Remove backing bars or runoff tabs, back gouge, and grind steel smooth.

2. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances of AISC's "Code of Standard Practice for Steel Buildings and Bridges" for mill material.

3. Verify that weld sizes, fabrication sequence, and equipment used for architecturally exposed structural steel will limit distortions to allowable tolerances. Prevent weld show-through on exposed steel surfaces.

a. Grind butt welds flush.

b. Grind or fill exposed fillet welds to smooth profile. Dress exposed welds.

## 2.8 SHOP PRIMING

A. Shop prime steel surfaces except the following:

1. Shop prime structural steel, except as modified herein, in accordance with SSPC PA 1. Do not prime steel surfaces embedded in concrete, galvanized surfaces, surfaces to receive sprayed-on fireproofing, surfaces to receive epoxy coatings, surfaces designed as part of a composite steel concrete section, or surfaces within 0.5 inch of the toe of the welds prior to welding, except surfaces on which metal decking is to be welded. Prior to assembly, prime surfaces which will be concealed or inaccessible after assembly. Do not apply primer in foggy or rainy weather; when the ambient temperature is below 45 degrees F or over 95 degrees F; or when the primer may be exposed to temperatures below 40 degrees F within 48 hours after application, unless approved otherwise by the Engineer.

B. Surface Preparation: Clean surfaces to be painted. Prepare surfaces according to the following specifications and standards:

1. SSPC SP 6, except steel exposed in spaces above ceilings, attic spaces, furred spaces, and chases that will be hidden to view in finished construction may be cleaned to SSPC SP 3 when recommended by the shop primer manufacturer. Maintain steel surfaces free from rust, mill scale, spatter, slag, flux, dirt, oil, grease, and other contaminants through final assembly.

C. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a dry film thickness of not less than 2 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces. Repair damaged primed surfaces with an additional coat of primer.

1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

2. Apply two coats of shop paint to inaccessible surfaces after assembly or erection. Change color of second coat to distinguish it from first.

## 2.9 GALVANIZING

A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to ASTM A 123/A 123M.

1. Fill vent and drain holes that will be exposed in the finished Work unless they will function as weep holes, by plugging with zinc solder and filing off smooth.

2. Galvanize lintels, shelf angles and welded door frames attached to structural-steel frame and located in exterior walls.

3. All structural steel, bolts, connectors and fasteners exposed to moisture shall be galvanized.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Verify, with steel Erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.

1. Prepare a certified survey of bearing surfaces, anchor rods, bearing plates, and other embedments showing dimensions, locations, angles, and elevations.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place unless otherwise indicated.

1. Do not remove temporary shoring supporting composite deck construction until cast-in-place concrete has attained its design compressive strength.

### 3.3 ERECTION

A. Set structural steel accurately in locations and to elevations indicated and according to AISC 303 and AISC 360.

B. Base, Bearing and Leveling Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.

1. Set plates for structural members on wedges, shims, or setting nuts as required.

2. Weld plate washers to top of baseplate.

3. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.

4. Promptly pack grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.

C. Maintain erection tolerances of structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges."

D. Align and adjust various members that form part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.

1. Level and plumb individual members of structure.

2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.

E. Splice members only where indicated.

F. Remove erection bolts on welded, architecturally exposed structural steel; fill holes with plug welds; and grind smooth at exposed surfaces.

G. Do not use thermal cutting during erection.

H. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.

I. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1/D1.1M and manufacturer's written instructions.

## 3.4 FIELD CONNECTIONS

A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.

1. Joint Type: Snug tightened (U.N.O.).

A. Weld Connections: Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work.

1. Comply with AISC's "Code of Standard Practice for Steel Buildings and Bridges" and "Specification for Structural Steel Buildings--Allowable Stress Design and Plastic Design" for bearing, adequacy of temporary connections, alignment, and removal of paint on surfaces adjacent to field welds.

2. Remove backing bars or runoff tabs, back gouge, and grind steel smooth.

3. Verify that weld sizes, fabrication sequence, and equipment used for architecturally exposed structural steel will limit distortions to allowable tolerances. Prevent weld show-through on exposed steel surfaces.

a. Grind butt welds flush.

b. Grind or fill exposed fillet welds to smooth profile. Dress exposed welds.

## 3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified independent testing and inspecting agency to inspect the erected steel in the field. This inspection shall also include alignment, position of member, welds and high-strength bolted connections, painting, etc. The inspection agency shall also submit to the Structural Engineer certified reports showing results of these inspections.

B. Bolted Connections: Shop-bolted connections will be inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

C. Welded Connections: Field welds will be visually inspected according to AWS D1.1.

1. Should deficiencies in welds be noted by visual inspection then field welds may be tested according to AWS D1.1 and the following inspection procedures, at Owner's option:

a. Liquid Penetrant Inspection: ASTM E 165.

b. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.

c. Ultrasonic Inspection: ASTM E 164.

d. Radiographic Inspection: ASTM E 94.

2. In addition to the visual inspection as indicated above, ultrasonic testing of all groove welds which are in tension and 25% of all groove welds which are in compression shall be required. The testing shall be done using "Branson" ultrasonic testing equipment, or other approved non-destructive testing systems. If faulty welds are discovered by this testing, costs of repair and any additional tests shall be borne by the Contractor.

D. Should visual inspection identify deficiencies in welded shear connectors, then field-welded shear connectors may be tested according to requirements in AWS D1.1 for stud welding at Owner's option as follows:

1. Perform bend tests if visual inspections reveal either a less-than- continuous 360-degree flash or welding repairs to any shear connector.

2. Conduct tests on additional shear connectors if weld fracture occurs on shear connectors already tested, according to requirements in AWS D1.1.

E. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

F. Submit final certified inspection report letter signed and sealed by P.E. licensed in the state of Maryland, indicating that the steel, including corrected deficiencies as erected meets all of the requirements of the Contract Documents.

## 3.6 REPAIRS AND PROTECTION

A. Galvanized Surfaces: Clean areas where galvanizing is damaged or missing and repair galvanizing to comply with ASTM A 780.

B. Touchup Painting: After installation, promptly clean, prepare, and prime or reprime field connections, rust spots, and abraded surfaces of prime-painted joists and accessories**,** bearing plates, and abutting structural steel where primer is damaged or missing and paint with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

1. Clean and prepare surfaces by SSPC-SP 3.

C. Touchup Painting: Cleaning and touchup painting are specified in Section 09911 "Exterior Painting" and Section 09912 "Interior Painting."

## PART 4 - MEASUREMENT AND PAYMENT

### 4.1 METHOD OF MEASUREMENT

A. The materials and labor associated with this specification section shall be measured on a lump sum basis. Payment shall be based on estimated quantity of work performed. The price shall be full compensation for all work contained in the bid item as described herein and required by the related Sections. Costs include all labor, materials, services, tools, equipment and incidentals necessary to complete the Work in every respect.

### 4.2 BASIS OF PAYMENT

A. Payment will be made under:

1. 8004 Structural Modifications [per lump sum].

END OF SECTION 051200

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

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

1.2 SUMMARY:

A. Section Includes:
1. Composite floor deck.

B. This project is to be “LEED” certified and have the following requirements:
1. Recycle content minimum 25 percent post-consumer up to 90 percent where possible.

C. Related Requirements:
1. Division 05 Section "Structural Steel Framing" for shop- and field-welded shear connectors.
2. Division 09 painting Sections for repair painting of primed deck and finish painting of deck.

1.3 ACTION SUBMITTALS:

A. Product Data: For each type of deck, accessory, and product indicated.

B. LEED Submittals:
1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.
2. Laboratory Test Reports for Credit EQ 4: For primers, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Shop Drawings:
1. Include layout and types of deck panels, anchorage details, reinforcing channels, pans, cut deck openings, special jointing, accessories, and attachments to other construction.

1.4 INFORMATIONAL SUBMITTALS:

A. Welding certificates.

B. Product Certificates: For each type of steel deck.

C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating that each of the following complies with requirements:
   1. Power-actuated mechanical fasteners.
   2. Acoustical roof deck.

D. Evaluation Reports: For steel deck.

E. Field quality-control reports.

1.5 QUALITY ASSURANCE:

A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.3, "Structural Welding Code - Sheet Steel."

C. Electrical Raceway Units: Provide UL-labeled cellular floor-deck units complying with UL 209 and listed in UL's "Electrical Construction Equipment Directory" for use with standard header ducts and outlets for electrical distribution systems.

D. FM Global Listing: Provide steel roof deck evaluated by FM Global and listed in its "Approval Guide, Building Materials" for Class 1 fire rating and Class 1-90 windstorm ratings.

1.6 DELIVERY, STORAGE, AND HANDLING:

A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.

B. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.
   1. Protect and ventilate acoustical cellular roof deck with factory-installed insulation to maintain insulation free of moisture.

## PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS:

A. AISI Specifications: Comply with calculated structural characteristics of steel deck according to AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members."

B. Fire-Resistance Ratings: Comply with ASTM E 119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

C. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

D. Low-Emitting Materials: Paints and coatings shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.2 COMPOSITE FLOOR DECK:

A. Composite Floor Deck: Fabricate panels, with integrally embossed or raised pattern ribs and interlocking side laps, to comply with "SDI Specifications and Commentary for Composite Steel Floor Deck," in SDI Publication No. 31, with the minimum section properties indicated, and with the following:
   1. Galvanized-Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 33 zinc coating.
   2. Profile Depth: As indicated.
   3. Span Condition: As indicated.

2.3 ACCESSORIES:

A. General: Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.

B. Mechanical Fasteners: Corrosion-resistant, low-velocity, power-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws.

C. Side-Lap Fasteners: Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, No. 10 minimum diameter.

D. Flexible Closure Strips: Vulcanized, closed-cell, synthetic rubber.

E. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 33,000 psi, not less than 0.0359-inch design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.

F. Pour Stops and Girder Fillers: Steel sheet, minimum yield strength of 33,000 psi, of same material and finish as deck, and of thickness and profile recommended by SDI Publication No. 31 for overhang and slab depth.

G. Column Closures, End Closures, Z-Closures, and Cover Plates: Steel sheet, of same material, finish, and thickness as deck unless otherwise indicated.

H. Piercing Hanger Tabs: Piercing steel sheet hanger attachment devices for use with floor deck.

I. Recessed Sump Pans: Single-piece steel sheet, 0.0747 inch thick, of same material and finish as deck, with 3-inch- wide flanges and level recessed pans of 1-1/2-inch minimum depth. For drains, cut holes in the field.

J. Galvanizing Repair Paint: ASTM A 780.

K. Repair Paint: Manufacturer's standard rust-inhibitive primer of same color as primer.

**PART 3 - EXECUTION**

3.1 EXAMINATION:

A. Examine supporting frame and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL:

A. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 31, manufacturer's written instructions, and requirements in this Section.

B. Install temporary shoring before placing deck panels if required to meet deflection limitations.

C. Locate deck bundles to prevent overloading of supporting members.

D. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.
   1. Align cellular deck panels over full length of cell runs and align cells at ends of abutting panels.

E. Place deck panels flat and square and fasten to supporting frame without warp or deflection.

F. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.

G. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.

H. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.

I. Mechanical fasteners may be used in lieu of welding to fasten deck. Locate mechanical fasteners and install according to deck manufacturer's written instructions.

3.3 FLOOR-DECK INSTALLATION:

A. Fasten floor-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated and as follows:
   1. Weld Diameter: 5/8 inch, nominal.
   2. Weld Spacing: Weld edge ribs of panels at each support. Space additional welds an average of 12 inches apart, but not more than 18 inches apart.
   3. Weld Spacing: Space and locate welds as indicated.

B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of half of the span or 36 inches, and as follows:
   1. Mechanically fasten with self-drilling, No. 10 diameter or larger, carbon-steel screws.
   2. Mechanically clinch or button punch.
   3. Fasten with a minimum of 1-1/2-inch- long welds.

C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 1-1/2 inches, with end joints as follows:
   1. End Joints: Lapped or butted at Contractor's option.

D. Pour Stops and Girder Fillers: Weld steel sheet pour stops and girder fillers to supporting structure according to SDI recommendations unless otherwise indicated.

E. Floor-Deck Closures: Weld steel sheet column closures, cell closures, and Z-closures to deck, according to SDI recommendations, to provide tight-fitting closures at open ends of ribs and sides of deck.

F. Install piercing hanger tabs at 14 inches apart in both directions, within 9 inches of walls at ends, and not more than 12 inches from walls at sides unless otherwise indicated.

3.4 FIELD QUALITY CONTROL:

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Field welds will be subject to inspection.

C. Testing agency will report inspection results promptly and in writing to Contractor and Architect.

D. Remove and replace work that does not comply with specified requirements.

E. Additional inspecting, at Contractor's expense, will be performed to determine compliance of corrected work with specified requirements.

3.5 PROTECTION:

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

B. Repair Painting: Wire brush and clean rust spots, welds, and abraded areas on top surface of prime-painted deck immediately after installation, and apply repair paint.
   1. Apply repair paint, of same color as adjacent shop-primed deck, to bottom surfaces of deck exposed to view.
   2. Wire brushing, cleaning, and repair painting of bottom deck surfaces are included in Division 09.

C. Repair Painting: Wire brushing, cleaning, and repair painting of rust spots, welds, and abraded areas of both deck surfaces are included in Division 09.

D. Provide final protection and maintain conditions to ensure that steel deck is without damage or deterioration at time of Substantial Completion.

END OF SECTION

# SECTION 054400 - COLD-FORMED METAL TRUSSES

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section includes cold-formed steel framing in the form of the following:

1. Cold-formed steel trusses for roofs.

### 1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

### 1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Include layout, spacings, sizes, thicknesses, and types of cold-formed steel trusses; fabrication; and fastening and anchorage details, including mechanical fasteners.
2. Indicate reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.

C. Delegated-Design Submittal: For cold-formed steel trusses, provide calculations & shop drawings signed & sealed by a professional engineer registered in the state of Maryland for review and approval by the Architect / Engineer.

### 1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Welding certificates.

C. Product Test Reports: For each listed product, for tests performed by manufacturer and witnessed by a qualified testing agency.

1. Steel sheet.
2. Expansion anchors.
3. Power-actuated anchors.
4. Mechanical fasteners.
5. Miscellaneous structural clips and accessories.

D. Evaluation Reports: For post-installed anchors and power-actuated fasteners, from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.

E. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

B. Product Tests: Mill certificates or data from a qualified independent testing agency indicating steel sheet complies with requirements, including base-metal thickness, yield strength, tensile strength, total elongation, chemical requirements, and metallic-coating thickness.

C. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."

## PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Aegis Metal Framing.
2. MarinoWARE.
3. TrusSteel; an ITW company.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design cold-formed steel trusses.

B. Structural Performance: Provide cold-formed steel trusses capable of withstanding design loads within limits and under conditions indicated.

1. Design Loads: As indicated on Drawings.
2. Deflection Limits: Design trusses to withstand design loads without deflections greater than the following:

a. Roof Trusses: Vertical deflection of 1/360 of the span.

3. Design trusses to provide for movement of truss members located outside the insulated building envelope without damage or overstressing, sheathing failure, connection failure, undue strain on fasteners and anchors, or other detrimental effects when subject to a maximum ambient temperature change of 120 deg F.

C. Cold-Formed Steel Truss Standards: Unless more stringent requirements are indicated, trusses shall comply with the following:

1. Floor and Roof Systems: AISI S210.
2. Lateral Design: AISI S213.
3. Roof Trusses: AISI S214.

D. Fire-Resistance Ratings: Comply with ASTM E 119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Indicate design designations from UL or from the listings of another qualified testing agency acceptable to authorities having jurisdiction.

## 2.3 COLD-FORMED STEEL TRUSS MATERIALS

A. Steel Sheet: ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated, of grade and coating designation as follows:

1. Grade: As required by structural performance.
2. Coating: G60, A60, AZ50, or GF30.

## 2.4 ROOF TRUSSES

A. Roof Truss Members: Manufacturer's standard C-shaped steel sections.

1. Connecting Flange Width: 1-5/8 inches, minimum at top and bottom chords connecting to sheathing or other directly fastened construction.
2. Minimum Base-Metal Thickness: 0.0329 inch.

## 2.5 TRUSS ACCESSORIES

A. Fabricate steel-truss accessories from steel sheet, ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated steel sheet, of same grade and coating designation used for truss members.

B. Provide accessories of manufacturer's standard thickness and configuration unless otherwise indicated.

## 2.6 ANCHORS, CLIPS, AND FASTENERS

A. Steel Shapes and Clips: ASTM A 36/A 36M, zinc coated by hot-dip process according to ASTM A 123/A 123M.

B. Anchor Bolts: ASTM F 1554, Grade 36, threaded carbon-steel hex-headed bolts, carbon-steel nuts, and flat, hardened-steel washers; zinc coated by hot-dip process according to ASTM A 153/A 153M, Class C.

C. Post-Installed Anchors: Fastener systems with bolts of same basic metal as fastened metal, if visible, unless otherwise indicated; with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC01 as appropriate for the substrate.

1. Uses: Securing cold-formed steel trusses to structure.
2. Type: Torque-controlled adhesive anchor.
3. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, unless otherwise indicated.

D. Power-Actuated Fasteners: Fastener systems with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

E. Mechanical Fasteners: ASTM C 1513, corrosion-resistant-coated, self-drilling, self-tapping steel drill screws.

1. Head Type: Low-profile head beneath sheathing; manufacturer's standard elsewhere.

F. Welding Electrodes: Comply with AWS standards.

## 2.7 MISCELLANEOUS MATERIALS

A. Galvanizing Repair Paint: ASTM A 780/A 780M.

B. Shims: Load-bearing, high-density multimonomer, nonleaching plastic; or cold-formed steel of same grade and metallic coating as truss members supported by shims.

2.8 FABRICATION

A. Fabricate cold-formed steel trusses and accessories plumb, square, and true to line, and with connections securely fastened, according to referenced AISI's specifications and standards, manufacturer's written instructions, and requirements in this Section.

1. Fabricate trusses using jigs or templates.
2. Cut truss members by sawing or shearing; do not torch cut.
3. Fasten cold-formed steel truss members by welding, screw fastening, clinch fastening, pneumatic pin fastening, or riveting as standard with fabricator.

a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.

4. Fasten other materials to cold-formed steel trusses by welding, bolting, pneumatic pin fastening, or screw fastening, according to Shop Drawings.

B. Reinforce, stiffen, and brace trusses to withstand handling, delivery, and erection stresses. Lift fabricated trusses by means that prevent damage or permanent distortion.

C. Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable variation of 1/8 inch in 10 feet and as follows:

1. Spacing: Space individual truss members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.
2. Squareness: Fabricate each cold-formed steel truss to a maximum out-of-square tolerance of 1/8 inch.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine substrates, areas, conditions, and abutting trusses and framing for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.2 PREPARATION

A. Before sprayed fire-resistive materials are applied, attach continuous angles, supplementary framing, or tracks to structural members indicated to receive sprayed fire-resistive materials.

B. After applying sprayed fire-resistive materials, remove only as much of these materials as needed to complete installation of cold-formed steel trusses without reducing thickness of fire-resistive materials below that required to obtain fire-resistance ratings indicated. Protect remaining fire-resistive materials from damage.

## 3.3 INSTALLATION

A. Install bridge, and brace cold-formed steel trusses according to AISI S200, AISI S202, AISI S214, and manufacturer's written instructions unless more stringent requirements are indicated.

1. Coordinate with wall framing to align webs of bottom chords and load-bearing studs or continuously reinforce track to transfer loads to structure.
2. Anchor trusses securely at all bearing points.
3. Install continuous bridging and permanently brace trusses as indicated on Shop Drawings and designed according to CFSEI's Technical Note 551e, "Design Guide: Permanent Bracing of Cold-Formed Steel Trusses."

B. Install cold-formed steel trusses and accessories true to line and location, and with connections securely fastened.

1. Erect trusses with plane of truss webs plumb and parallel to each other. Align and accurately position trusses at required spacings.
2. Erect trusses without damaging truss members or connections.
3. Fasten cold-formed steel trusses by welding or mechanical fasteners.

    a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
    b. Locate mechanical fasteners, install according to Shop Drawings, and comply with requirements for spacing, edge distances, and screw penetration.

C. Install temporary bracing and supports to secure trusses and support loads equal to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to trusses are secured.

D. Truss Spacing: 24 inches maximum.

E. Do not alter, cut, or remove truss members or connections of trusses.

## 3.4 ERECTION TOLERANCES

A. Install cold-formed steel trusses level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:

1. Space individual trusses no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

## 3.5 FIELD QUALITY CONTROL

A. Special Inspections: Engage a qualified special inspector to perform the following special inspections:

1. Cold-Formed Steel Trusses Spanning 60 ft. (18,288 mm) or Longer: Verify temporary installation restraint/bracing and the permanent individual truss member restraint/bracing are installed according to the approved truss submittal package.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Cold-formed metal trusses will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

## 3.6 REPAIRS AND PROTECTION

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed steel trusses with galvanized repair paint according to ASTM A 780/A 780M and manufacturer's written instructions.

B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that cold-formed steel trusses are without damage or deterioration at time of Substantial Completion.

END OF SECTION 054400

# SECTION 055000 – METAL FABRICATION

## PART 1 – GENERAL

### 1.1 DESCRIPTION

A. This section specifies miscellaneous metalwork, which consists of metal fabrication other than structural metal framing.

### 1.2 REFERENCES

A. Details and fabrication of metal fabrications shall conform to the following publications.

B. American Institute of Steel Construction (AISC)

1. AISC Manual of Steel Construction".

C. American National Standards Institute (ANSI)

1. ANSI A14.3 Ladders – Fixed – Safety Requirements

D. American Society of Mechanical Engineers (ASME)

1. ASME B18.2.1 Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series)

2. ASME B18.6.1 Wood Screws (Inch Series)

3. ASME B18.6.3 Machine Screws, Tapping Screws, and Metallic Drive Screws (Inch Series)

4. ASME 18.22.1 Plain Washers

E. ASTM International (ASTM)

1. ASTM A27 Standard Specification for Steel Castings, Carbon, for General Application

2. ASTM A36 Standard Specification for Carbon Structural Steel

3. ASTM A48 Standard Specification for Gray-Iron Castings

4. ASTM A47 Standard Specification for Ferritic Malleable Iron Castings

5. ASTM A53 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

6. ASTM A123 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

7. ASTM A153 Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

8. ASTM A283 Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates

9. ASTM A307 Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength

10. ASTM A320 Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for Low Temperature Service

11. ASTM A489 Standard Specification for Carbon Steel Lifting Eyes

12. ASTM A500 Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes

13. ASTM A563 Standard Specification for Carbon and Alloy Steel Nuts

14. ASTM A780 Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings

15. ASTM A1011 Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability

16. ASTM B26 Standard Specification for Aluminum-Alloy Sand Castings

17. ASTM B209 Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate

18. ASTM B210 Standard Specification for Aluminum and Aluminum-Alloy Drawn Seamless Tubes

19. ASTM B221 Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles and Tubes

20. ASTM B632 Standard Specification for Aluminum-Alloy Rolled Tread Plate

21. ASTM B633 Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel

22. ASTM C1107 Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)

23. ASTM D1187 Standard Specification for Asphalt-Base Emulsions for Use as Protective Coatings for Metal

24. ASTM E488 Standard Test Methods for Strength of Anchors in Concrete Elements

25. ASTM F593 - 13 Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs

26. ASTM F594 Standard Specification for Stainless Steel Nuts

27. ASTM F1554 Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength

F. American Welding Society (AWS)

1. AWS D1.1 Structural Welding Code—Steel

2. AWS D1.2 Structural Welding Code—Aluminum

1.3 SUBMITTALS

A. Manufacturer's catalog data, including construction features, dimensional data, technical information, which define details of construction that demonstrate compliance with this specification.

B. Fabrication drawings and installation drawings that provide sufficient information including detailed dimensional information to fabricate and install all metal fabrications.

C. Shop drawings for metal stairs and landings shall be signed and sealed by a professional engineer licensed in the State of Maryland.

D. Submit design calculations for metal stairs and landings. Calculations shall be signed and sealed by a professional engineer licensed in the State of Maryland.

E. Welding certificates.

1.4 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code--Steel."

2. AWS D1.2, "Structural Welding Code--Aluminum."

1.5 PROJECT CONDITIONS

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

1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating metal fabrications without field measurements. Coordinate wall and other contiguous construction to ensure that actual dimensions correspond to established dimensions.

2. Provide allowance for trimming and fitting at site.

1.6 COORDINATION

A. Coordinate installation of anchorages for metal fabrications. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

B. Coordinate installation of steel weld plates and angles for casting into concrete that are specified in this Section but required for work of another Section. Deliver such items to Project site in time for installation.

1.7 CONTRACTOR FURNISHED STAIR DESIGNS

A. The Contractor shall furnish designs for interior and exterior metal stairs, with associated landings, and guardrails.

B. Designs shall include all fasteners to concrete structures.

C. For exterior aluminum stairs, designs shall include foundation supports and concrete base slabs.

D. Stairs designs shall comply with all applicable OSHA regulations and prevailing building codes.

1.8 PERFORMANCE REQUIREMENTS

A. Structural Performance of Ladders: Provide ladders capable of withstanding the effects of loads and stresses within limits and under conditions specified in ANSI A14.3.

B. Thermal Movements: Provide exterior metal fabrications that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

**PART 2 – PRODUCTS**

2.1 METALS, GENERAL

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces, unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

2.2 MATERIALS

A. Materials for miscellaneous metalwork shall be as specified in Table 1.

**Table 1. Materials for Miscellaneous Metalwork**

| Material | Specification |
|---|---|
| Nonstructural steel bars, angles, clips, plates, shapes, and similar items | ASTM A36 or ASTM A283 |
| Steel pipe | ASTM A 53, Schedule 40, unless another weight is indicated or required by structural loads |
| Iron castings | |

**Table 1. Materials for Miscellaneous Metalwork**

| Material | Specification |
|---|---|
| | ASTM A48, Class 30, unless another class is indicated or required by structural loads. |
| Structural steel tubing | ASTM A500, Grade B |
| Steel bolts (except flanges and anchor bolts) | ASTM A307, Grade A |
| Stainless steel | ASTM A320, Type 304, except where otherwise noted |
| Aluminum seamless tubes | ASTM B210 |
| Aluminum bars, rods, wire, shapes and tubes, and other extrusions | ASTM B221, Alloy 6061-T6 |
| Aluminum plate and sheet | ASTM B 209, Alloy 6061-T6 |
| Aluminum-alloy rolled tread plate | ASTM B 632, Alloy 6061-T6 |
| Aluminum Castings | ASTM B 26, Alloy 443.0-F |

2.3 FASTENERS

A. General: Unless otherwise indicated, provide Type 304 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633, Class Fe/Zn 5, at exterior walls. Provide stainless-steel fasteners for fastening aluminum. Select fasteners for type, grade, and class required.

B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A; with hex nuts, ASTM A 563; and, where indicated, flat washers.

C. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, nuts and, where indicated, flat washers; ASTM F 593 for bolts and ASTM F 594 for nuts, Alloy Group 1.

D. Anchor Bolts

1. Provide hot-dip galvanized anchor bolts, conforming to ASTM F1554, Grade 36, where item being fastened is indicated to be galvanized.

2. Provide ASTM F593 bolts and ASTM F594 nuts, Group 1, where stainless steel is indicated.

E. Eyebolts: ASTM A489.

F. Machine Screws: ASME B18.6.3.

G. Lag Bolts: ASME B18.2.1.

H. Wood Screws: Flat head, ASME B18.6.1.

I. Plain Washers: Round, ASME B18.22.1.

J. Lock Washers: Helical, spring type, ASME B18.21.1.

K. Expansion Anchors: Anchor bolt and sleeve assembly with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.

1. Alloy Group 1 stainless-steel bolts complying with ASTM F 593 and nuts complying with ASTM F 594.

2.4 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

B. Shop Primers: Provide primers that comply with Division 09 painting Sections.

C. Zinc-Rich Primer: Complying with SSPC-Paint 20 or SSPC-Paint 29 and compatible with topcoat.

1. Use primer with a VOC content of 420 g/L (3.5 lb/gal.) or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. Galvanizing Repair Paint: High-zinc-dust-content paint for regalvanizing welds in steel, complying with SSPC-Paint 20.

E. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

F. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

G. Concrete Materials and Properties: Comply with requirements in Division 03 Section "Cast-in-Place Concrete" for normal-weight, air-entrained, ready-mix concrete with a minimum 28-day compressive strength of 5,000 psi, unless otherwise indicated.

2.5 FABRICATION

A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch, unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

D. Form exposed work true to line and level with accurate angles and surfaces and straight edges.

E. Weld corners and seams continuously to comply with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

2. Obtain fusion without undercut or overlap.

3. Remove welding flux immediately.

4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) screws or bolts, unless otherwise indicated. Locate joints where least conspicuous.

G. Fabricate seams and other connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

I. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

1. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/8 by 1-1/2 inches, with a minimum 6-inch embedment and 2-inch hook, not less than 8 inches from ends and corners of units and 24 inches o.c., unless otherwise indicated.

J. Holes shall be punched 1/16 inch larger than the nominal size of the bolts, unless otherwise specified. Whenever needed, because of the thickness of the metal, holes shall be subpunched and reamed or shall be drilled.

K. Fabrication including cutting, drilling, punching, threading and tapping required for miscellaneous metal or adjacent work shall be performed prior to hot-dip galvanizing.

L. Iron Castings: Castings shall be as specified on the drawings. Castings weighing less than 100 pounds shall be hot-dip galvanized after machining. Castings weighing greater than 100 pounds shall be galvanized where specified.

M. Cover Plates: Cover plates (Checkered Plate) shall be Alcoa C 102 aluminum tread plate, Reynolds diamond tread plate, or approved equal. No single piece of floor and cover plate shall weigh more than 80 pounds unless specifically detailed otherwise.

N. Ladders: Unless otherwise specified, ladders shall be of all aluminum construction.

O. Safety Stair Nosings: Safety stair nosings shall be 4 inches wide and shall be Alumogrit, Type 101 as manufactured by Wooster Products, Incorporated, Alumalum Style A as manufactured by American Abrasive Metals Company, Style AX as manufactured by Safe T Metal Company, Inc., or approved equal.

P. Other Miscellaneous Steel Metalwork: Other miscellaneous steel metalwork including embedded and nonembedded steel metalwork, hangers and inserts shall be as specified on the drawings and shall be hot-dip galvanized after fabrication.

## 2.6 MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work. Items include but not limited to the following:

1. Steel framing and supports for overhead doors.

2. Steel framing and supports for mechanical and electrical equipment.

3. Steel framing and supports for applications where framing and supports are not specified in other Sections.

4. Miscellaneous steel trim including steel angle corner guards, steel edgings and loading-dock edge angles.

5. Metal Bollards.

B. Fabricate units from steel shapes, plates, and bars of welded construction, unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction retained by framing and supports. Cut, drill, and tap units to receive hardware, hangers, and similar items.

1. Fabricate units from slotted channel framing where indicated.

2. Furnish inserts if units are installed after concrete is placed.

C. Galvanize miscellaneous framing and supports.

D. Prime miscellaneous framing and supports with zinc-rich primer.

## 2.7 LOOSE STEEL LINTELS

A. Fabricate loose steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated. Weld adjoining members together to form a single unit where indicated.

B. Size loose lintels to provide bearing length at each side of openings equal to 1/12 of clear span but not less than 8 inches, unless otherwise indicated.

C. Galvanize loose steel lintels located in exterior walls.

D. Prime loose steel lintels located in exterior walls with zinc-rich primer.

2.8 SHELF ANGLES

A. Fabricate shelf angles from steel angles of sizes indicated and for attachment to concrete framing. Provide horizontally slotted holes to receive 3/4-inch bolts, spaced not more than 6 inches from ends and 24 inches o.c., unless otherwise indicated.

1. Provide mitered and welded units at corners.

2. Provide open joints in shelf angles at expansion and control joints. Make open joint approximately 2 inches larger than expansion or control joint.

B. For cavity walls, provide vertical channel brackets to support angles from backup masonry and concrete.

C. Galvanize shelf angles located in exterior walls.

D. Furnish wedge-type concrete inserts, complete with fasteners, to attach shelf angles to cast-in-place concrete.

2.9 LOOSE BEARING AND LEVELING PLATES

A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.

B. Galvanize plates after fabrication.

2.10 STEEL WELD PLATES AND ANGLES

A. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with not less than two integrally welded steel strap anchors for embedding in concrete.

2.11 MISCELLANEOUS STEEL TRIM

A. Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.

B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.

1. Provide with integrally welded steel strap anchors for embedding in concrete or masonry construction.

C. Galvanize exterior miscellaneous steel trim and interior miscellaneous steel trim, where indicated.

2.12 METAL LADDERS

A. General:

1. Comply with ANSI A14.3, unless otherwise indicated.

2. Space siderails 18 inches apart, unless otherwise indicated.

3. Support each ladder at top and bottom and not more than 60 inches o.c. with welded or bolted brackets, made from same metal as ladder.

B. Aluminum Ladders:

1. Side rails: Continuous extruded-aluminum channels or tubes, not less than 2-1/2 inches deep, 3/4 inch wide, and 1/8 inch thick.

2. Rungs: Extruded-aluminum tubes, not less than 3/4 inch deep and not less than 1/8 inch thick, with ribbed tread surfaces.

3. Fit rungs in centerline of side rails; fasten by welding or with stainless-steel fasteners or brackets and aluminum rivets.

2.13 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Finish metal fabrications after assembly.

2.14 STEEL AND IRON FINISHES

A. Galvanizing: Hot-dip galvanize items as indicated to comply with applicable standard listed below:

1. ASTM A 123, for galvanizing steel and iron products.

2. ASTM A 153, for galvanizing steel and iron hardware.

B. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with minimum requirements indicated below for SSPC surface preparation

specifications and environmental exposure conditions of installed metal fabrications:

1. Exteriors (SSPC Zone 1B) and Items Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

2. Interiors (SSPC Zone 1A): SSPC-SP 3, "Power Tool Cleaning."

C. Shop Priming: Apply shop primer to uncoated surfaces of metal fabrications, except those with galvanized finishes and those to be embedded in concrete, sprayed-on fireproofing, or masonry, unless otherwise indicated. Comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

2.15 ALUMINUM FINISHES

A. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

B. Class I, Clear Anodic Finish: AA-M12C22A41 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.

## PART 3 – EXECUTION

3.1 INSTALLATION

A. General:

1. Fieldwork shall not be permitted on galvanized items. Drilling of bolts or enlargement of holes to correct misalignment will not be allowed.

2. Holes shall be punched 1/16 inch larger than the nominal size of the bolts, unless otherwise specified. Whenever needed, because of the thickness of the metal, holes shall be subpunched and reamed or shall be drilled. Cutting, drilling, punching, threading and tapping shall be performed prior to hot dip galvanizing.

3. Dissimilar metals shall be protected from galvanic corrosion by means of pressure tapes, coatings or isolators.

4. Metalwork to be embedded in concrete shall be placed accurately and held in correct position while the concrete is placed or, if specified, recesses or blockouts shall be formed in the concrete. The surfaces of metalwork in contact with or embedded in concrete shall be thoroughly cleaned. If accepted, recesses may be neatly cored in the concrete after it has attained its design strength and the metalwork grouted in place.

B. Seat Angles, Supports and Guides: Seat angles for grating and supports for floor plates shall be set so that they are flush with the floor and also maintain the grating and floor plates flush with the floor.

C. Cover Plates: Cover plates shall be field measured for proper cutouts and proper sizes.

D. Ladders: Ladders shall be fitted accurately and field measured where necessary.

E. Safety Stair Nosings: Unless otherwise specified, safety stair nosings shall be installed on all concrete stairs. Nosings shall be secured to concrete with suitable anchors at 15 inches on centers and not more than 4 inches from the ends. Rubber tape, 1/8 inch thick, shall be provided at both ends and cut to fit shape of tread prior to concrete placement.

F. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

G. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

H. Field Welding: Comply with the following requirements:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

2. Obtain fusion without undercut or overlap.

3. Remove welding flux immediately.

4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

I. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag bolts, wood screws, and other connectors.

J. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

K. Corrosion Protection: Coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals with a heavy coat of bituminous paint.

3.2 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.

B. Anchor supports for operable partitions securely to and rigidly brace from building structure.

C. Support steel girders on solid grouted masonry, concrete, or steel pipe columns. Secure girders with anchor bolts embedded in grouted masonry or concrete or with bolts through top plates of pipe columns.

1. Where grout space under bearing plates is indicated for girders supported on concrete or masonry, install as specified in "Installing Bearing and Leveling Plates" Article.

D. Install pipe columns on concrete footings with grouted baseplates. Position and grout column baseplates as specified in "Installing Bearing and Leveling Plates" Article.

1. Grout baseplates of columns supporting steel girders after girders are installed and leveled

3.3 ADJUSTING AND CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.

B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Division 09 painting Sections.

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

END OF SECTION 055000

# SECTION 055116 - METAL FLOOR PLATE STAIRS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Industrial Class steel floor diamond plate for exterior stair treads, risers, landing, and loading dock platform.

### 1.2 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written instructions to ensure that shop primers and topcoats are compatible with one another.

### 1.3 ACTION SUBMITTALS

A. Product Data: For metal floor plate stairs and the following:

1. Metal floor plate.

B. Shop Drawings:

1. Include plans, elevations, sections, details, and attachments to other work.
2. Indicate sizes of metal sections, thickness of metals, profiles, holes, and field joints.
3. Include plan at each level.
4. Indicate locations of anchors, weld plates, and blocking for attachment of wall-mounted handrails.

### 1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For professional engineer's experience with providing delegated-design engineering services of the kind indicated, including documentation that engineer is licensed in the State in which Project is located.

B. Welding certificates.

### 1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

PART 2 - PRODUCTS

## 2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design stairs, including attachment to building construction.

B. Structural Performance of Stairs: Metal stairs shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated on the Structural Engineering drawings.

C. Seismic Performance of Stairs: indicated on the Structural Engineering drawings.

## 2.2 METALS

A. Steel Plates, Shapes, and Bars: ASTM A36/A36M.

B. Rolled-Steel Floor Plate: ASTM A786/A786M, rolled from plate complying with ASTM A36/A36M or ASTM A283/A283M, Grade C or D.

## 2.3 FASTENERS

A. General: Provide zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 12 for exterior use, and Class Fe/Zn 5 where built into exterior walls.

B. Fasteners for Anchoring Railings to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction indicated and capable of withstanding design loads.

C. Post-Installed Anchors: Torque-controlled expansion anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E488/E488M, conducted by a qualified independent testing agency.

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, unless otherwise indicated.
2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 stainless-steel bolts, ASTM F593, and nuts, ASTM F594.

## 2.4 MISCELLANEOUS MATERIALS

A. Shop Primers: Provide primers that comply with Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

B. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint systems indicated.

C. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

## 2.5 FABRICATION, GENERAL

A. Provide complete stair assemblies, including metal framing, hangers, railings, clips, brackets, bearing plates, and other components necessary to support and anchor stairs and platforms on supporting structure.

1. Join components by welding unless otherwise indicated.
2. Use connections that maintain structural value of joined pieces.

B. Assemble stairs in shop to greatest extent possible.

1. Disassemble units only as necessary for shipping and handling limitations.
2. Clearly mark units for reassembly and coordinated installation.

C. Cut, drill, and punch metals cleanly and accurately.

1. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated.
2. Remove sharp or rough areas on exposed surfaces.

D. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

E. Form exposed work with accurate angles and surfaces and straight edges.

F. Weld connections to comply with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Weld exposed corners and seams continuously unless otherwise indicated.
5. At exposed connections, finish exposed welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Finish # 3 - Partially dressed weld with spatter removed.

G. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible.

1. Where exposed fasteners are required, use Phillips flat-head (countersunk) screws or bolts unless otherwise indicated.
2. Locate joints where least conspicuous.
3. Fabricate joints that will be exposed to weather in a manner to exclude water.
4. Provide weep holes where water may accumulate internally.

2.6 FABRICATION OF STEEL-FRAMED STAIRS

A. NAAMM Stair Standard: Comply with NAAMM AMP 510, "Metal Stairs Manual," for Industrial Class, unless more stringent requirements are indicated.

B. Stair Framing:

1. Fabricate stringers of steel channels.

C. Stringer Size:

a. indicated on the Structural Engineering drawings.
b. Provide closures for exposed ends of channel stringers.
c. Finish: Shop primed.

2. Construct platforms and tread supports of steel plate or channel headers and miscellaneous framing members as required to comply with "Performance Requirements" Article indicated on Drawings.

a. Provide closures for exposed ends of channel framing.
b. Finish: Shop primed.

3. Where masonry walls support metal stairs, provide temporary supporting struts designed for erecting steel stair components before installing masonry.

D. Metal Floor Plate Stairs: Form treads and platforms to configurations shown from rolled-steel floor plate of thickness indicated on the Structural Engineering drawings.

1. Form treads with integral nosing and back edge stiffener. Form risers of same material as treads.
2. Fabricate treads and platforms of exterior stairs so finished walking surfaces slope to drain.

E. Risers: Solid.

F. Toe Plates: Provide toe plates around openings and at edge of open-sided floors and platforms, and at open ends and open back edges of treads.

1. Material and Finish: Match treads and platforms.
2. Fabricate to dimensions and details indicated.

2.7 FINISHES

A. Finish metal stairs after assembly.

B. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A153/A153M for steel and iron hardware and with ASTM A123/A123M for other steel and iron products.

1. Do not quench or apply post-galvanizing treatments that might interfere with paint adhesion.

2. Fill vent and drain holes that will be exposed in finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.

C. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

1. Exterior Stairs: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
2. Interior Stairs: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

D. Apply shop primer to uncoated surfaces of metal stair components, except those with galvanized finishes and those to be embedded in concrete or masonry unless otherwise indicated. Comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

## PART 3 - EXECUTION

### 3.1 INSTALLING METAL STAIRS

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal stairs to in-place construction.

1. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.

B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal stairs. Set units accurately in location, alignment, and elevation, measured from established lines and levels and free of rack.

C. Install metal stairs by welding stair framing to steel structure or to weld plates cast into concrete unless otherwise indicated.

1. Grouted Baseplates: Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces.

a. Clean bottom surface of baseplates.
b. Set steel stair baseplates on wedges, shims, or leveling nuts.
c. After stairs have been positioned and aligned, tighten anchor bolts.
d. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with grout.
e. Promptly pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

1) Neatly finish exposed surfaces; protect grout and allow to cure.
2) Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.

D. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

E. Fit exposed connections accurately together to form hairline joints.

1. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations.
2. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
3. Comply with requirements for welding in "Fabrication, General" Article.

## 3.2 REPAIR

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.

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

END OF SECTION 055116

# SECTION 055213 - PIPE AND TUBE RAILINGS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Steel tube railings: Stair railing (hand, guard, and posts).

2. Woven wire mesh: guard rail infill panels.

### 1.2 ACTION SUBMITTALS

A. Product Data: For the following:
1. Railing brackets.
2. Grout, anchoring cement, and paint products.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

C. Samples: For each type of exposed finish required.

D. Delegated-Design Submittal: For railings, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

### 1.3 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For pipe and tube railings, for tests performed by a qualified testing agency, according to ASTM E894 and ASTM E935.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design railings, including attachment to building construction.

B. Structural Performance: Railings, including attachment to building construction, shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Handrails and Top Rails of Guards:

a. Uniform load of 50 lbf/ ft. applied in any direction.
b. Concentrated load of 200 lbf applied in any direction.

c. Uniform and concentrated loads need not be assumed to act concurrently.

2. Infill of Guards:

a. Concentrated load of 50 lbf applied horizontally on an area of 1 sq. ft..
b. Infill load and other loads need not be assumed to act concurrently.

## 2.2 METALS, GENERAL

A. Brackets, Flanges, and Anchors: Cast or formed metal of same type of material and finish as supported rails unless otherwise indicated.

1. Provide type of bracket with flange tapped for concealed anchorage to threaded hanger bolt and that provides 1-1/2-inch clearance from inside face of handrail to finished wall surface.

## 2.3 STEEL AND IRON

A. Tubing: ASTM A500 (cold formed).

B. Pipe: ASTM A53/A53M, Type F or Type S, Grade A, Standard Weight (Schedule 40), unless another grade and weight are required by structural loads.

1. Provide galvanized finish for exterior installations and where indicated.

C. Plates, Shapes, and Bars: ASTM A36/A36M.

D. Woven-Wire Mesh: Intermediate-crimp, diamond and square pattern, 2-inch woven-wire mesh, made from 0.134-inch-diameter wire complying with ASTM A510.

## 2.4 FASTENERS

A. General: Provide the following:
1. Hot-Dip Galvanized Railings: Type 304 stainless-steel or hot-dip zinc-coated steel fasteners complying with ASTM A153/A153M or ASTM F2329 for zinc coating.

B. Post-Installed Anchors: Torque-controlled expansion anchors capable of sustaining, without failure, a load equal to 6 times the load imposed when installed in unit masonry and 4 times the load imposed when installed in concrete, as determined by testing according to ASTM E488/E488M, conducted by a qualified independent testing agency.

1. Material for Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B633 or ASTM F1941, Class Fe/Zn 5, unless otherwise indicated.
2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 stainless-steel bolts, ASTM F593, and nuts, ASTM F594.

## 2.5 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

B. Etching Cleaner for Galvanized Metal: Complying with MPI#25.

C. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.

## 2.6 FABRICATION

A. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

B. Form work true to line and level with accurate angles and surfaces.

C. Welded Connections: Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove flux immediately.
4. At exposed connections, finish exposed surfaces smooth and blended so no roughness shows after finishing and welded surface matches contours of adjoining surfaces.

D. Form changes in direction by bending.

E. For changes in direction made by bending, use jigs to produce uniform curvature for each repetitive configuration required. Maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.

F. Close exposed ends of railing members with prefabricated end fittings.

G. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated.

H. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work unless otherwise indicated.

I. Woven-Wire Mesh Infill Panels: Fabricate infill panels from woven-wire mesh crimped into 1-by-1/2-by-1/8-inch metal channel frames. Make wire mesh and frames from same metal as railings in which they are installed.

1. Orient wire mesh with wires perpendicular and parallel to top rail as indicated on Drawings.

PART 3 - EXECUTION

## 3.1 INSTALLATION, GENERAL

A. Set railings accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.

1. Do not weld, cut, or abrade surfaces of railing components that are coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
2. Set posts plumb within a tolerance of 1/16 inch in 3 feet.
3. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet.

B. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

1. Coat, with a heavy coat of bituminous paint, concealed surfaces of aluminum that are in contact with grout, concrete, masonry, wood, or dissimilar metals.

## 3.2 ATTACHING RAILINGS

A. Attach railings to wall with wall brackets. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.

B. Return rail extensions as indicated on the Architectural drawings.

C. Secure wall brackets and railing end flanges to building construction as follows:

1. For concrete and solid masonry anchorage, use drilled-in expansion shields and hanger or lag bolts.
2. For hollow masonry anchorage, use toggle bolts.

## 3.3 ADJUSTING AND CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop painting to comply with SSPC-PA 1 requirements for touching up shop-painted surfaces.

END OF SECTION 055213

# METAL GRATING – SECTION 055300

## PART 1 – GENERAL

1.1 DESCRIPTION

A. This section specifies floor grating and grating stair treads. Unless otherwise indicated on Drawings, floor grating and stair grating treads shall be galvanized steel. Steel grating shall only be used where indicated on the Drawings.

1.2 QUALITY ASSURANCE

A. Metal grating shall conform to the following publications.

B. NAAMM (National Association of Architectural Metal Manufacturers)

1. NAAMM MBG 531—Metal Bar Grating Manual.

2. Shop NAAMM MBG 532—Heavy Duty Metal Bar Grating Manual.

C. ASTM:

1. ASTM A36—"Standard Specification for Carbon Structural Steel."

1.3 SUBMITTALS

A. The following submittals shall be provided in accordance with Section 01 33 21:

1. Catalog data which demonstrate compliance with this specification.

2. Shop drawings that show complete dimensional information, details of construction, anchor detail and installation details. Dimensions shall be based on actual field dimensions to assure proper fit.

## PART 2 – PRODUCTS

2.1 MATERIALS

A. Steel Grating:

1. Steel grating bearing bars and cross bars shall be of welding quality mild carbon steel conforming to ASTM A1011. Cross bars shall be electroforge welded to bearing bars at 4 inches maximum. Bearing bar top surface shall be serrated. Grating sections shall be hot dipped galvanized after fabrication.

2. Grating shall be able to carry a uniform load of 100 pounds per square foot with a deflection not exceeding 1/4 inch. Bearing bar size shall not be less than indicated on the drawings.

2.2 FABRICATION

A. General:

1. Both bearing bars and cross bars shall be continuous.

2. All grating shall be end banded with bars the same thickness of the bearing bars except at I-bar bearing bars where the thickness shall be 1/8 inch minimum. End banding shall be the height of the bearing bar minus 1/4 inch with the top of the end banding level with the top of the bearing bars. At heavy duty grating, the end banding shall be welded to every bearing bar. At non-heavy duty grating, the end banding may be welded to alternate bearing bars so as not exceed a spacing of 5 inches.

3. Rough weld beads and sharp metal edges on gratings shall be ground smooth. Welds exposed to view shall be uniform and neat. Welds to be galvanized shall be sandblasted prior to galvanizing.

4. Grating shall bear a minimum of 1 inch on supports except for heavy duty steel grating which shall bear a minimum of 2 inches on supports.

5. No single piece of grating shall weigh more than 80 pounds unless specifically detailed otherwise.

6. Cutouts for circular obstructions shall be 2 inches minimum, 3 inches maximum, larger in diameter than obstruction. All openings shall be banded with bars having the same dimensions as the bearing bars except where only one bearing bar is cut. Bar shall be welded to each bearing bar cut at opening. Cutouts shall not cut more than 40% of the bearing bars in a grating panel.

7. Each section of grating shall be anchored to supports with a minimum of four anchors, two per end, approximately 6 inches from each side. All anchoring systems shall not protrude above the top of the grating except for saddle clips. Anchoring by welding shall not be acceptable. Anchors for other bar type gratings shall be with 316 stainless steel saddle clips. Anchors for aluminum plank grating shall be of aluminum construction made specifically for such grating. Bolts utilized in all anchors shall be minimum 1/4-inch diameter, 316 stainless steel.

## PART 3 – EXECUTION

### 3.1 INSTALLATION

A. General:

1. Installation shall be in accordance with shop drawings and NAAMM 531 and NAAMM 532, as applicable and the additional items in this section.

2. Fieldwork shall not be permitted on galvanized items. Drilling of bolts or enlargement of holes to correct misalignment will not be allowed.

3. Dissimilar metals shall be protected from galvanic corrosion by means of pressure tapes, coatings or isolators. Aluminum in contact with concrete shall be protected by a coat of bituminous paint.

4. Metalwork to be embedded in concrete shall be placed accurately and held in correct position while the concrete is placed or, if specified, recesses or blockouts shall be formed in the concrete after it has attained its design strength and the metalwork grouted in place. The surfaces of metalwork in contact with or embedded in concrete shall be thoroughly cleaned, and if of aluminum construction, coated with bituminous paint.

5. Grating shall be field measured for proper cutouts and proper sizes.

6. Install such that no gap exceeds 1/2 inch.

3.2 CLEANING

A. After installation, damaged surfaces of shop primed metals shall be cleaned and touched up with the same material used for the shop coat. Damaged surfaces of galvanized metals shall be repaired.

END OF SECTION 055300

# SECTION 061000 - ROUGH CARPENTRY

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. This Section includes the following:

1. Wood blocking and nailers.
2. Plywood backing panels.

### 1.3 DEFINITIONS

A. Lumber grading agencies, and the abbreviations used to reference them, include the following:

1. NLGA - National Lumber Grades Authority.
2. SPIB - Southern Pine Inspection Bureau.
3. WCLIB - West Coast Lumber Inspection Bureau.
4. WWPA - Western Wood Products Association.

### 1.4 SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.

1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used, net amount of preservative retained, and chemical treatment manufacturer's written instructions for handling, storing, installing, and finishing treated material.
2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials, both before and after exposure to elevated temperatures when tested according to ASTM D 5516 and ASTM D 5664.
3. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.

4. Include copies of warranties from chemical treatment manufacturers for each type of treatment.

B. Research/Evaluation Reports: For the following, showing compliance with building code in effect for Project:

1. Preservative-treated wood.
2. Fire-retardant-treated wood.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Stack lumber, plywood, and other panels; place spacers between each bundle to provide air circulation. Provide for air circulation around stacks and under coverings.

## PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

A. Lumber: DOC PS 20 and applicable rules of lumber grading agencies certified by the American Lumber Standards Committee Board of Review.

1. Factory mark each piece of lumber with grade stamp of grading agency.
2. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry lumber.
3. Provide dressed lumber, S4S, unless otherwise indicated.
4. Provide dry lumber with 19 percent maximum moisture content at time of dressing for 2-inch nominal thickness or less, unless otherwise indicated.

B. Wood Structural Panels:

1. Plywood: Either DOC PS 1 or DOC PS 2, unless otherwise indicated.
2. Thickness: As needed to comply with requirements specified but not less than thickness indicated.
3. Factory mark panels according to indicated standard.

2.2 FIRE-RETARDANT-TREATED MATERIALS

A. General: Where fire-retardant-treated materials are indicated, provide materials that comply with performance requirements in AWPA C20 (lumber) and AWPA C27 (plywood). Identify fire-retardant-treated wood with appropriate classification marking of UL, U.S. Testing, Timber Products Inspection, or another testing and inspecting agency acceptable to authorities having jurisdiction.

1. Use treatment for which chemical manufacturer publishes physical properties of treated wood after exposure to elevated temperatures, when tested by a qualified independent testing agency according to ASTM D 5664, for lumber and ASTM D 5516, for plywood.
2. Use treatment that does not promote corrosion of metal fasteners.
3. Use Exterior type for exterior locations and where indicated.
4. Use Interior Type A High Temperature (HT), unless otherwise indicated.

## 2.3 MISCELLANEOUS LUMBER

A. General: Provide lumber for support or attachment of other construction, including the following:

1. Blocking.
2. Nailers.
3. Furring.
4. Grounds.

B. For items of dimension lumber size, provide Construction, Stud, or No. 2 grade lumber with 19 percent maximum moisture content and any of the following species:

1. Mixed southern pine; SPIB.
2. Hem-fir or Hem-fir (north); NLGA, WCLIB, or WWPA.

C. For concealed boards, provide lumber with 19 percent maximum moisture content and any of the following species and grades:

1. Mixed southern pine, No. 2 grade; SPIB.
2. Hem-fir or Hem-fir (north), Construction or 2 Common grade; NLGA, WCLIB, or WWPA.

## 2.4 PANEL PRODUCTS

A. Telephone and Electrical Equipment Backing Panels: DOC PS 1, Exposure 1, C-D plugged, fire-retardant treated, in thickness indicated or, if not indicated, not less than 1/2 inch thick.

## 2.5 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this Article for material and manufacture.

1. Where carpentry is exposed to weather, in ground contact, or in area of high relative humidity, and all preservative treated and fire retardant treated wood, provide

fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M, or of Type 304 stainless steel.

B. Nails, Wire, Brads, and Staples: FS FF-N-105.

C. Power-Driven Fasteners: CABO NER-272.

D. Wood Screws: ASME B18.6.1.

E. Screws for Fastening to Cold-Formed Metal Framing: ASTM C 954, except with wafer heads and reamer wings, length as recommended by screw manufacturer for material being fastened.

F. Lag Bolts: ASME B18.2.1.

G. Bolts: Steel bolts complying with ASTM A 307, Grade A; with ASTM A 563 hex nuts and, where indicated, flat washers.

H. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to 6 times the load imposed when installed in unit masonry assemblies and equal to 4 times the load imposed when installed in concrete as determined by testing per ASTM E 488 conducted by a qualified independent testing and inspecting agency.

1. Material: Stainless steel with bolts and nuts complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2.

## PART 3 - EXECUTION

### 3.1 INSTALLATION, GENERAL

A. Discard units of material with defects that impair quality of carpentry and that are too small to use with minimum number of joints or optimum joint arrangement.

B. Set carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit carpentry to other construction; scribe and cope as needed for accurate fit. Locate nailers, blocking, and similar supports to comply with requirements for attaching other construction.

C. Apply field treatment complying with AWPA M4 to cut surfaces of preservative-treated lumber and plywood.

D. Securely attach carpentry work as indicated and according to applicable codes and recognized standards.

E. Countersink fastener heads on exposed carpentry work and fill holes with wood filler.

F. Use fasteners of appropriate type and length. Pre-drill members when necessary to avoid splitting wood.

3.2 WOOD BLOCKING, AND NAILER INSTALLATION

A. Install where indicated and where required for attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.

B. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces, unless otherwise indicated.

3.3 PANEL PRODUCT INSTALLATION

A. Wood Structural Panels: Comply with applicable recommendations contained in APA Form No. E30K, "APA Design/Construction Guide: Residential & Commercial," for types of structural - use panels and applications indicated.

END OF SECTION 061000

# SECTION 071113 – BITUMINOUS DAMPPROOFING

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:

1. Cold-applied asphalt dampproofing for precast electric manholes.

B. Related Requirements:

1. Section 03410 "Precast Structural Concrete" for manhole dampproofing.
2. Section 02584 “Underground Ducts and Utility Structures” for ductbank dampproofing.
3. Section 03300 “Cast-In-Place Concrete” for manhole dampproofing.

### 1.3 SUBMITTALS

A. Product Data: For each type of product.

### 1.4 FIELD CONDITIONS

A. Weather Limitations: Proceed with application only when existing and forecasted weather conditions permit dampproofing to be performed according to manufacturers' written instructions.

B. Ventilation: Provide adequate ventilation during application of dampproofing in enclosed spaces. Maintain ventilation until dampproofing has cured.

## PART 2 - PRODUCTS

### 2.1 MATERIALS, GENERAL

A. Source Limitations: Obtain primary dampproofing materials and primers from single source from single manufacturer. Provide auxiliary materials recommended in writing by manufacturer of primary materials.

B. VOC Content: Products shall comply with VOC content limits of authorities having jurisdiction unless otherwise required.

2.2 COLD-APPLIED, EMULSIFIED-ASPHALT DAMPPROOFING

A. Trowel Coats: ASTM D 1227, Type II, Class 1.

B. Fibered Brush and Spray Coats: ASTM D 1227, Type II, Class 1.

C. Brush and Spray Coats: ASTM D 1227, Type III, Class 1.

D. VOC Content: 30 g/L or less.

E. Low-Emitting Materials: Dampproofing shall comply with the testing and product requirements of the Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.3 AUXILIARY MATERIALS

A. General: Furnish auxiliary materials recommended in writing by dampproofing manufacturer for intended use and compatible with bituminous dampproofing.

B. Cut-Back-Asphalt Primer: ASTM D 41.

C. Emulsified-Asphalt Primer: ASTM D 1227, Type III, Class 1, except diluted with water as recommended in writing by manufacturer.

1. Primer shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

D. Asphalt-Coated Glass Fabric: ASTM D 1668, Type I.

E. Patching Compound of type recommended in writing by dampproofing manufacturer.

F. Protection Course: Extruded-polystyrene board insulation, unfaced, ASTM C 578, Type X, 1/2 inch thick.

G. Protection Course: Smooth-surfaced roll roofing complying with ASTM D 6380, Class S, Type III.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions with Applicator present, for compliance with requirements for surface smoothness, surface moisture, and other conditions affecting performance of bituminous dampproofing work.

1. Test for surface moisture according to ASTM D 4263.

B. Proceed with application only after substrate construction and penetrating work have been completed and unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Mask or otherwise protect adjoining exposed surfaces from being stained, spotted, or coated with dampproofing. Prevent dampproofing materials from entering and clogging weep holes and drains.

B. Clean substrates of projections and substances detrimental to the dampproofing work; fill voids, seal joints, and remove bond breakers if any, as recommended in writing by prime material manufacturer.

C. Apply patching compound to patch and fill tie holes, honeycombs, reveals, and other imperfections.

3.3 APPLICATION, GENERAL

A. Comply with manufacturer's written instructions for dampproofing application, cure time between coats, and drying time before backfilling unless more stringent requirements are indicated.

1. Apply dampproofing to provide continuous plane of protection.
2. Apply additional coats if recommended in writing by manufacturer or to achieve a smooth surface and uninterrupted coverage.

3.4 COLD-APPLIED, EMULSIFIED-ASPHALT DAMPPROOFING

A. Concrete Manholes: Apply two brush or spray coats at not less than 2 gal./100 sq. ft. for first coat and 1 gal./100 sq. ft. for second coat. The final thickness of dampproofing shall be 60 mils thick.

## 3.5 INSTALLATION OF PROTECTION COURSE

A. Where indicated, install protection course over completed-and-cured dampproofing. Comply with dampproofing-material and protection-course manufacturers' written instructions for attaching protection course.

1. Support protection course over cured coating with spot application of adhesive type recommended in writing by protection-board manufacturer.

## 3.6 CLEANING

A. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended in writing by manufacturer of affected construction.

END OF SECTION 07113

# SECTION 072100 - THERMAL INSULATION

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Extruded polystyrene foam-plastic board. (Slab and foundation locations).
2. Blown-in. (Attic and loading dock ceiling locations).
3. Cavity wall insulation. See Chapter 072100

### 1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

### 1.3 INFORMATIONAL SUBMITTALS

A. Product test reports.

B. Research reports.

## PART 2 - PRODUCTS

### 2.1 EXTRUDED POLYSTYRENE FOAM-PLASTIC BOARD

A. Extruded polystyrene boards in this article are also called "XPS boards."

B. Extruded Polystyrene Board, Type VI: ASTM C 578, Type VI, 40-psi minimum compressive strength; maximum flame-spread and smoke-developed indexes of 25 and 450, respectively, per ASTM E 84.

C. R-value: minimum R5 per inch.

### 2.2 ACCESSORIES

A. Insulation for Miscellaneous Voids:

1. Glass-Fiber Insulation: ASTM C 764, Type II, loose fill; with maximum flame-spread and smoke-developed indexes of 5, per ASTM E 84.

B. Insulation Anchors, Spindles, and Standoffs: As recommended by manufacturer.

C. Adhesive for Bonding Insulation: Product compatible with insulation and air and water barrier materials, and with demonstrated capability to bond insulation securely to substrates without damaging insulation and substrates.

D. Eave Ventilation Troughs: Preformed, rigid fiberboard or plastic sheets designed and sized to fit between roof framing members and to provide ventilation between insulated attic spaces and vented eaves.

## PART 3 - EXECUTION

### 3.1 INSTALLATION, GENERAL

A. Comply with insulation manufacturer's written instructions applicable to products and applications.

B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.

C. Extend insulation to envelop entire area to be insulated. Fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.

D. Provide sizes to fit applications and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units unless multiple layers are otherwise shown or required to make up total thickness or to achieve R-value.

### 3.2 INSTALLATION OF SLAB INSULATION

A. On vertical slab edge and foundation surfaces, set insulation units using manufacturer's recommended adhesive according to manufacturer's written instructions.

B. On horizontal surfaces, loosely lay insulation units according to manufacturer's written instructions. Stagger end joints and tightly abut insulation units.

C. On vertical surfaces, butt panels together for tight fit. Install adhesive according to manufacturer’s written instructions.

### 3.3 INSTALLATION OF CAVITY-WALL INSULATION

A. See Chapter 072100UW

END OF SECTION 072100

# SECTION 072100UW - ULTRA WALL INSULATION AND AIR BARRIER SYSTEM WITH CAVITYMATE ULTRA

## PART 1 – GENERAL

### 1.01 SECTION INCLUDES

A. Ultra Wall System; extruded polystyrene (XPS) board insulation.
   1. Square edge cavity wall insulation fit between wall ties; STYROFOAM Brand CAVITYMATE Ultra.

### 1.02 RELATED REQUIREMENTS

A. Section 04 2000 - Unit Masonry: Cavity wall veneers.
B. Section 04 2723 - Cavity Wall Unit Masonry: Cavity wall veneers.
C. Section 09 2116 - Gypsum Board Assemblies: Gypsum wall sheathing substrate in cavity.
D. [Continue as appropriate for project]

### 1.03 REFERENCE STANDARDS

A. ASTM C578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation; 2016.
B. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2016.
C. ASTM E331 - Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference; 2000 (Reapproved 2016).
D. ASTM E2178 - Standard Test Method for Air Permeance of Building Materials; 2013.
E. ASTM E2357 - Standard Test Method for Determining Air Leakage of Air Barrier Assemblies; 2011.
F. NFPA 285 - Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Non-Load-Bearing Wall Assemblies Containing Combustible Components; 2012.

### 1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide data on product characteristics for each type of product indicated.
C. NFPA 285 Compliance: Submit third party documentation showing wall assembly compliance with NFPA 285.
D. Warranty: Provide Manufacturer’s Limited Thermal Warranty for extruded polystyrene insulation.

1.05 QUALITY ASSURANCE

A. Thermal Insulation: Not produced with, or contain, any of U.S. EPA regulated chlorofluorocarbon (CFC) compounds listed in Montreal Protocol of United Nations Environmental Program.

B. Surface Burning Characteristics: As determined by testing identical products according to ASTM E84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

C. Air Barrier Performance: Provide insulation and related materials with information from manufacturer indicating insulation has passed testing with ASTM E2178-13 “Standard Test Method for determining Air Leakage for building materials and/or the assembly has passed testing in accordance with ASTM E2357-05, “Standard Test Method for Determining Air Leakage of Air Barrier Assemblies”.

D. Source Limitations: Obtain each type of building insulation through one source from a single manufacturer.

1.06 MOCK-UP

A. Provide mock-up of specified system illustrating proper installation of specified wall assembly in compliance with manufacturer's recommendations.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Protect thermal insulation materials from physical damage and from deterioration due to moisture, soiling and other sources; store in dry interior location.

1. Do not expose to direct sunlight. Exposure limit 90 days.
2. Protect against ignition at all times.
3. Quickly complete installation and concealment of foam plastic board installation in each area of construction.

B. Comply with manufacturer’s recommendations for delivery, storage, and handling.

1.08 FIELD CONDITIONS

A. Installation Temperatures: Comply with manufacturer’s recommendations for temperatures during product installation.

B. Environmental Requirements: Install this work in compliance with manufacturer’s environmental requirements, and during conditions in accordance with manufacturer’s recommended minimum surface temperatures.

1.09 WARRANTY

A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

B. Wall System: Provide 50 Year Thermal Limited Warranty in United States for STYROFOAM insulation products 1-1/2 inch thick and greater.

PART 2 – PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Air Barrier: Tested in accordance with ASTM E2357 at pressure of 6.24 psf or greater, with air infiltration less than 0.04 cfm/sq ft of fixed wall area.

1. Conduct testing at positive and negative sustained wind loading of 12.5 psf for one-hour duration in each direction.
2. Provide pressure cycling of wall at 2000 cycles in both positive and negative directions, ending with wind gust loading at 25 psf.

B. Water Penetration: Tested in accordance with ASTM E331, with minimum pressure differential of 6.24 psf for at least two hour test duration without any uncontrolled water penetration.

1. All joints, penetrations, and gaps of the thermal (and air) layer wall system shall be made water and air tight.

2.02 CAVITYMATE ULTRA - WALL INSULATION SYSTEM

A. Extruded Polystyrene (XPS) Board Insulation: Complies with ASTM C578, Type IV with patented carbon-black technology wall insulation system placed between wall anchors of masonry veneer cavity walls and with seam treatment to form a continuous thermal, air, and water barrier system.

1. Basis of Design:

a. Dow Chemical Company; STYROFOAM CAVITYMATE Ultra: www.dowbuildingsolutions.com

2. Flame Spread Index (FSI): Class A - 0 to 25, when tested in accordance with ASTM E84.
3. Smoke Developed Index (SDI): 450 or less, when tested in accordance with ASTM E84.
4. Compressive Resistance: At least 25 psi.
5. Density: At least 1.45 lbs/cu ft.
6. Water Vapor Permeance: Maximum of 1.5 perms per 1 inch thickness.
7. Board Overall Dimensions: 15-3/4 inch wide by 96 inch long.
8. Board Thickness: Nominal thickness of as shown on drawings, with square edge treatment along edges.
9. Thermal Resistance (R-value): R-5.6/in at 75 degrees F.

2.03 ACCESSORIES

A. Gypsum Sheathing: Provide moisture and mold-resistant glass mat gypsum wall board in accordance with Section 09 2116.

B. Board Insulation Bonding Adhesive: Provide product as recommended by insulation manufacturer that will not damage insulation or substrates.

1. Products: GREAT STUFF PRO™ Gaps and Cracks single component polyurethane low-pressure sealant single component polyurethane low-pressure foam sealant as manufactured by Dow Chemical Company.

B. Foam Sealant Penetration Filler: Provide single component spray polyurethane foam (SPF) for sealing wall penetrations through board insulation.

1. Products: GREAT STUFF PRO™ Gaps and Cracks single component polyurethane low-pressure sealant or GREAT STUFF PRO™ Window and Door single component polyurethane low-pressure foam sealant as manufactured by Dow Chemical Company.

C. Face Repair Flashing: Provide board insulation manufacturer's recommended flashing for repair of damaged board insulation facer.

1. Products:

a. LIQUIDARMOR™ CM Spray Flashing and Sealant as manufactured by the Dow Chemical Company.
b. LIQUIDARMOR™ LT Flexible Single Component Silicone Flashing as manufactured by Dow Chemical Company.

E. Flashing and Sealant: Provide for sealing joints, seams and veneer tie penetrations through board insulation.

1. One component polyurethane foam

a. Product: GREAT STUFF PRO™ Gaps & Cracks as manufactured by The Dow Chemical Company for gaps >= 1/4" wide.

1. Spray applied elastomeric liquid flashing and sealant, grey-blue color.

a. Product: LIQUIDARMOR™ CM (for gaps < ¼”) as manufactured by Dow Chemical Company.

2. Trowel applied single component silicone flashing and sealant, grey color.

a. Product: LIQUIDARMOR™ LT (for gaps <1/4”) as manufactured by Dow Chemical Company.

F. Roof/Wall Juncture Sealing

1. Maintain continuity of air barrier by sealing the roof/wall juncture.
2. Acceptable Products:

a. The Dow Chemical Company; FROTH-PAK Foam Insulation (Class A).

PART 3 – EXECUTION

3.01 INSTALLATION, CAVITYMATE ULTRA WALL INSULATION SYSTEM

A. Comply with extruded polystyrene (XPS) board insulation manufacturer's installation instructions for applications indicated.

B. Apply 2 inch diameter daubs of adhesive at four corners of interior face of board insulation and one at the center, for total of five.

C. Place board insulation between wall ties and other obstructions with staggered joints and provide 1/4 inch to 1/2 inch wide gap at end joints.

1. Press board insulation units firmly against wall sheathing of cavity wall construction, and ensure insulation is continuous.

D. Fill open spaces between board insulation with single component foam sealant to ensure continuous air and water vapor barrier.

E. Install board insulation to cover entire insulated area, cut and fit insulation tightly around obstructions, and properly remove projections that interfere with insulation placement.

3.02 INSTALLATION, GENERAL

A. Roof/Wall Juncture:

1. Maintain continuity of air barrier by sealing the roof/wall juncture with Roof/Wall Juncture Sealing material.

B. Flashing and Sealant:

1. Apply material within application limits of product manufacturer.
2. Do not apply product on surfaces with standing water or frost.
3. Avoid installing on days with a high probability of significant rainfall.
4. Seal gaps greater than 1/4 inch in width with penetration filler prior to applying flashing and sealant.

a. If facer on board insulation is damaged, make note of affected area and apply additional spray over damaged area.

b. Replace damaged insulation, or repair facer flaws with appropriate flashing as recommended by insulation panel manufacturer.

5. Apply flashing and sealant to board joints, penetrations and other fenestration openings as required at material required application thickness.

   a. Apply flashing 3 inches, plus or minus 1 inch wide over board insulation joints, with at least 1 inch of spray covers each side of joint.
   b. Apply flashing over fasteners and washers along board insulation joints.
   c. Install façade attachment system after flashing has been applied.

6. Rough Openings: Apply flashing and sealant at least 3 inches onto face of insulation panel sheathing, and completely cover edge of insulation board; also spray at least 3 inch back onto rough opening substrate.

   a. It is recommended to cover back onto rough opening at least 1 inch past the interior weatherseal.

7. Board Insulation or Substrate Penetrations: Apply flashing and sealant at least 2 inches onto face of insulation sheathing and at least 2 inches onto penetration or primary flashing substrate.

8. Use wet mil thickness gauge to ensure proper installation thickness.
   a. Where consistently below minimum thickness, apply another layer to achieve proper thickness requirements.

9. Visually inspect for any areas missed and trowel on sealant as necessary.

## 3.03 PROTECTION

A. Protect board insulation from excess moisture, mechanical damage, and exposure to open flame.

B. Repair damage caused to board insulation in a manner that retains integrity and continuity of insulation and facer materials.

C. Keep board insulation dry and above water on jobsite, and cover with tarp until ready for installation.

D. Promptly cover board insulation with cladding.

END OF SECTION

# SECTION 074113.16 - STANDING-SEAM METAL ROOF PANELS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section includes standing-seam metal roof panels.

### 1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details.

C. Samples: For each type of metal panel indicated.

### 1.3 INFORMATIONAL SUBMITTALS

A. Product test reports.

B. Warranties: Sample of special warranties.

### 1.4 CLOSEOUT SUBMITTALS

A. Maintenance data.

### 1.5 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

B. UL-Certified, Portable Roll-Forming Equipment: UL-certified, portable roll-forming equipment capable of producing metal panels warranted by manufacturer to be the same as factory-formed products. Maintain UL certification of portable roll-forming equipment for duration of work.

### 1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal panel systems that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Finish Warranty Period: 35 years from date of Substantial Completion.

C. Special Weathertightness Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace standing-seam metal roof panel assemblies that fail to remain weathertight, including leaks, within specified warranty period.

1. Warranty Period: 20 years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E 1592:

1. Wind Loads: As indicated on Drawings.
2. Deflection Limits: For wind loads, no greater than 1/180 of the span.

B. Air Infiltration: Air leakage of not more than 0.06 cfm/sq. ft. when tested according to ASTM E 1680 at the following test-pressure difference:

1. Test-Pressure Difference: 1.57 lbf/sq. ft..

C. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E 1646 at the following test-pressure difference:

1. Test-Pressure Difference: 2.86 lbf/sq. ft..

D. Hydrostatic-Head Resistance: No water penetration when tested according to ASTM E 2140.

E. Wind-Uplift Resistance: Provide metal roof panel assemblies that comply with UL 580 for wind-uplift-resistance class indicated.

1. Uplift Rating: UL 90.

F. FM Global Listing: Provide metal roof panels and component materials that comply with requirements in FM Global 4471 as part of a panel roofing system and that are listed in FM Global's "Approval Guide" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Global markings.

1. Fire/Windstorm Classification: U.L. Class A rated Assembly, U.l. 263 And U.L. 790.
2. Hail Resistance: Class 4, U.L. 22/8.

G. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint

sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

## 2.2 STANDING-SEAM METAL ROOF PANELS

A. General: Provide factory-formed metal roof panels designed to be installed by lapping and interconnecting raised side edges of adjacent panels with joint type indicated and mechanically attaching panels to supports using concealed clips in side laps. Include clips, cleats, pressure plates, and accessories required for weathertight installation.

1. Steel Panel Systems: Unless more stringent requirements are indicated, comply with ASTM E 1514.

B. Vertical-Rib, Snap-Joint, Standing-Seam Metal Roof Panels: Formed with vertical ribs at panel edges and between ribs; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels, engaging opposite edge of adjacent panels, and snapping panels together.
1. Metallic-Coated Steel Sheet: Zinc-coated (galvanized) steel sheet complying with ASTM A 653/A 653M, G90 coating designation, or aluminum-zinc alloy-coated steel sheet complying with ASTM A 792/A 792M, Class AZ50 coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A 755/A 755M.

a. Nominal Thickness: 24 GA.
b. Exterior Finish: Two-coat fluoropolymer.
c. Color: As selected by Architect from manufacturer's full range.

2. Clips: One-piece fixed to accommodate thermal movement.

a. Material: 18 GA. nominal thickness, zinc-coated (galvanized).

3. Panel Coverage: 18 inches.
4. Panel Height: 1.75 inches.

## 2.3 UNDERLAYMENT MATERIALS

A. Self-Adhering, High-Temperature Underlayment: Provide self-adhering, cold-applied, sheet underlayment, a minimum of 30 mils thick, consisting of slip-resistant, polyethylene-film top surface laminated to a layer of butyl or SBS-modified asphalt adhesive, with release-paper backing. Provide primer when recommended by underlayment manufacturer.

1. Thermal Stability: Stable after testing at 240 deg F; ASTM D 1970.
2. Low-Temperature Flexibility: Passes after testing at minus 20 deg F; ASTM D 1970.

B. Felt Underlayment: ASTM D 226/D 22M, Type II (No. 30), asphalt-saturated organic felts.

C. Slip Sheet: Manufacturer's recommended slip sheet, of type required for application.

2.4 MISCELLANEOUS MATERIALS

A. Miscellaneous Metal Subframing and Furring: ASTM C 645; cold-formed, metallic-coated steel sheet, ASTM A 653/A 653M, G90 coating designation or ASTM A 792/A 792M, Class AZ50 coating designation unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of metal panel system.

B. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.

1. Closures: Provide closures at eaves and ridges, fabricated of same metal as metal panels.
2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
3. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch-thick, flexible closure strips; cut or premolded to match metal panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.

C. Flashing and Trim: Provide flashing and trim formed from same material as metal panels as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, eaves, rakes, corners, bases, framed openings, ridges, fasciae, and fillers. Finish flashing and trim with same finish system as adjacent metal panels.

D. Panel Fasteners: Self-tapping screws designed to withstand design loads.

E. Panel Sealants: Provide sealant type recommended by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish.

1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing; 1/2 inch wide and 1/8 inch thick.
2. Joint Sealant: ASTM C 920; as recommended in writing by metal panel manufacturer.
3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C 1311.

2.5 FABRICATION

A. General: Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

B. On-Site Fabrication: Subject to compliance with requirements of this Section, metal panels may be fabricated on-site using UL-certified, portable roll-forming equipment if panels are of same profile and warranted by manufacturer to be equal to factory-formed panels. Fabricate according to equipment manufacturer's written instructions and to comply with details shown.

C. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.

D. Fabricate metal panel joints with factory-installed captive gaskets or separator strips that provide a weathertight seal and prevent metal-to-metal contact, and that minimize noise from movements.

E. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.

## 2.6 FINISHES

A. Panels and Accessories:

1. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat.

# PART 3 - EXECUTION

## 3.1 PREPARATION

A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages according to ASTM C 754 and metal panel manufacturer's written recommendations.

## 3.2 UNDERLAYMENT INSTALLATION

A. Self-Adhering Sheet Underlayment: Apply primer if required by manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation. Apply at locations indicated below on Drawings, wrinkle free, in shingle fashion to shed water, and with end laps of not less than 6 inches staggered 24 inches between courses. Overlap side edges not less than 3-1/2 inches. Extend underlayment into gutter trough. Roll laps with roller. Cover underlayment within 14 days.

1. Apply over the entire roof surface.

B. Flashings: Install flashings to cover underlayment to comply with requirements specified in Section 076200 "Sheet Metal Flashing and Trim."

## 3.3 METAL PANEL INSTALLATION

A. Standing-Seam Metal Roof Panel Installation: Fasten metal roof panels to supports with concealed clips at each standing-seam joint at location, spacing, and with fasteners recommended in writing by manufacturer.

1. Install clips to supports with self-tapping fasteners.
2. Install pressure plates at locations indicated in manufacturer's written installation instructions.

3. Snap Joint: Nest standing seams and fasten together by interlocking and completely engaging factory-applied sealant.
4. Watertight Installation:

    a. Apply a continuous ribbon of sealant or tape to seal joints of metal panels, using sealant or tape as recommend in writing by manufacturer as needed to make panels watertight.
    b. Provide sealant or tape between panels and protruding equipment, vents, and accessories.
    c. At panel splices, nest panels with minimum 6-inch end lap, sealed with sealant and fastened together by interlocking clamping plates.

B. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.

C. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.

## 3.4 CLEANING AND PROTECTION

A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.

END OF SECTION 074113.16

# SECTION 074293 - SOFFIT PANELS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section includes metal soffit panels.

### 1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details.

C. Samples: For each type of metal panel indicated.

### 1.3 INFORMATIONAL SUBMITTALS

A. Product test reports.

B. Warranties: Samples of special warranties.

### 1.4 CLOSEOUT SUBMITTALS

A. Maintenance data.

### 1.5 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal panel systems that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

## 2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E 1592:

1. Wind Loads: As indicated on Drawings.
2. Deflection Limits: For wind loads, no greater than 1/180 of the span.

B. Air Infiltration: Air leakage of not more than 0.06 cfm/sq. ft. when tested according to ASTM E 283 at the following test-pressure difference:

1. Test-Pressure Difference: 1.57 lbf/sq. ft..

C. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E 331 at the following test-pressure difference:

1. Test-Pressure Difference: 2.86 lbf/sq. ft..

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

## 2.2 METAL SOFFIT PANELS

A. General: Provide metal soffit panels designed to be installed by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fasteners in side laps. Include accessories required for weathertight installation.

B. Flush-Profile Metal Soffit Panels: Perforated panels formed with vertical panel edges and intermediate stiffening ribs symmetrically spaced a flat pan between panel edges; with flush joint between panels.
1. Material: Same finish, and color as metal roof panels.

2. Aluminum Sheet: Coil-coated sheet, ASTM B 209, alloy as standard with manufacturer, with temper as required to suit forming operations and structural performance required.

a. Thickness: 0.032 inch.
b. Surface: Smooth, flat finish.
c. Exterior Finish: Two-coat fluoropolymer.
d. Color: As selected by Architect from manufacturer's full range.

3. Panel Coverage: 12 inches.
4. Panel Height: 0.50”.

## 2.3 MISCELLANEOUS MATERIALS

A. Miscellaneous Metal Subframing and Furring: ASTM C 645, cold-formed, metallic-coated steel sheet, ASTM A 653/A 653M, G90 coating designation or ASTM A 792/A 792M, Class AZ50 aluminum-zinc-alloy coating designation unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of metal panel system.

B. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.

1. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch-thick, flexible closure strips; cut or premolded to match metal panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.

C. Flashing and Trim: Provide flashing and trim formed from same material as metal panels as required to seal against weather and to provide finished appearance. Finish flashing and trim with same finish system as adjacent metal panels.

D. Panel Fasteners: Self-tapping screws designed to withstand design loads. Provide exposed fasteners with heads matching color of metal panels by means of plastic caps or factory-applied coating. Provide EPDM or PVC sealing washers for exposed fasteners.

E. Panel Sealants: Provide sealant types recommended by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish.

1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing; 1/8 inch thick.
2. Joint Sealant: ASTM C 920; as recommended in writing by metal panel manufacturer.
3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C 1311.

## 2.4 FABRICATION

A. General: Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

B. On-Site Fabrication: Subject to compliance with requirements of this Section, metal panels may be fabricated on-site using UL-certified, portable roll-forming equipment if panels are of same profile and warranted by manufacturer to be equal to factory-formed panels. Fabricate according to equipment manufacturer's written instructions and to comply with details shown.

C. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.

D. Fabricate metal panel joints with factory-installed captive gaskets or separator strips that provide a weathertight seal and prevent metal-to-metal contact, and that minimize noise from movements.

E. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.

## 2.5 FINISHES

A. Panels and Accessories:

1. Two-Coat Fluoropolymer: AAMA 621 and AAMA 2605. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

# PART 3 - EXECUTION

## 3.1 PREPARATION

A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages according to ASTM C 754 and metal panel manufacturer's written recommendations.

1. Soffit Framing: Wire tie or clip furring channels to supports, as required to comply with requirements for assemblies indicated.

## 3.2 METAL PANEL INSTALLATION

A. Metal Soffit Panels: Fasten metal panels to supports with fasteners at each lapped joint at location and spacing recommended by manufacturer.

1. Apply panels and associated items true to line for neat and weathertight enclosure.
2. Provide metal-backed washers under heads of exposed fasteners bearing on weather side of metal panels.
3. Locate and space exposed fasteners in uniform vertical and horizontal alignment. Use proper tools to obtain controlled uniform compression for positive seal without rupture of washer.
4. Install screw fasteners with power tools having controlled torque adjusted to compress washer tightly without damage to washer, screw threads, or panels. Install screws in predrilled holes.

B. Watertight Installation:

1. Apply a continuous ribbon of sealant or tape to seal lapped joints of metal panels, using sealant or tape as recommend by manufacturer on side laps of nesting-type panels and elsewhere as needed to make panels watertight.
2. Provide sealant or tape between panels and protruding equipment, vents, and accessories.
3. At panel splices, nest panels with minimum 6-inch end lap, sealed with sealant and fastened together by interlocking clamping plates.

C. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.

D. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that are permanently watertight.

## 3.3 CLEANING

A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.

END OF SECTION 074293

# SECTION 077100 - ROOF SPECIALTIES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Roof-edge specialties.
   2. Roof-edge drainage systems.

### 1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each type of roof specialty and for each color and texture specified.

### 1.3 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For tests performed by a qualified testing agency.

B. Sample warranty.

### 1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For roofing specialties to include in maintenance manuals.

### 1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer offering products meeting requirements that are FM Approvals listed for specified class.

### 1.6 WARRANTY

A. Roofing-System Warranty: Roof specialties are included in warranty provisions in Section 74113.16 .

B. Special Warranty on Painted Finishes: Manufacturer agrees to repair finish or replace roof specialties that show evidence of deterioration of factory-applied finishes within specified warranty period.

   1. Fluoropolymer Finish: Deterioration includes, but is not limited to, the following:

      a. Color fading more than 5 Hunter units when tested according to ASTM D2244.

b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: 20 years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

A. FM Approvals' Listing: Manufacture and install roof-edge specialties that are listed in FM Approvals' "RoofNav" and approved for windstorm classification, Class 1-60. Identify materials with FM Approvals' markings.

B. SPRI Wind Design Standard: Manufacture and install roof-edge specialties tested according to SPRI ES-1 and capable of resisting the following design pressures:

1. Design Pressure: As indicated on Drawings.

C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, hole elongation, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Provide clips that resist rotation and avoid shear stress as a result of thermal movements. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

### 2.2 ROOF-EDGE SPECIALTIES

1. Metallic-Coated Steel Sheet Fascia Covers: Zinc-coated (galvanized) steel, nominal 0.028-inch thickness.

a. Surface: Smooth, flat finish.
b. Finish: Two-coat fluoropolymer.
c. Color: As selected by Architect from manufacturer's full range.

2. Corners: Factory mitered and mechanically clinched and sealed watertight.
3. Splice Plates: Concealed, of same material, finish, and shape as fascia cover.

### 2.3 ROOF-EDGE DRAINAGE SYSTEMS

A. Gutters: Manufactured in uniform section lengths not exceeding 12 feet, with matching corner units, ends, outlet tubes, and other accessories. Elevate back edge at least 1 inch above front edge. Furnish flat-stock gutter straps, gutter brackets, expansion joints, and expansion-joint covers fabricated from same metal as gutters.

1. Zinc-Coated Steel: Nominal 0.028-inch thickness.
2. Gutter Profile: Half-round single bead according to SMACNA's "Architectural Sheet Metal Manual."

3. Corners: Factory mitered and mechanically clinched and sealed watertight.
4. Gutter Supports: Gutter brackets with finish matching the gutters.
5. Finish: Two-coat fluoropolymer.
6. Color: As selected by Architect from manufacturer's full range.

B. Downspouts: Plain round complete with machine-crimped mitered elbows, manufactured from the following exposed metal. Furnish with metal hangers, from same material as downspouts, and anchors.

1. Zinc-Coated Steel: Nominal 0.028-inch thickness.
2. Finish: Two-coat fluoropolymer.
3. Color: As selected by Architect from manufacturer's full range.

2.4 Roof Edge Trim:

A. Roof edge trim: Manufactured units of heights to overlap top edges of base flashings by 4 inches and in lengths not exceeding 12 feet designed to snap into and compress against base flashings with joints lapped, from the following exposed metal:

1. Zinc-Coated Steel: Nominal 0.022-inch thickness.
2. Finish: Two-coat fluoropolymer.
3. Color: As selected by Architect from manufacturer's full range.

2.5 MISCELLANEOUS MATERIALS

A. Fasteners: Manufacturer's recommended fasteners, suitable for application and designed to meet performance requirements. Furnish the following unless otherwise indicated:

1. Exposed Penetrating Fasteners: Gasketed screws with hex washer heads matching color of sheet metal.

B. Elastomeric Sealant: ASTM C920, elastomeric silicone polymer sealant of type, grade, class, and use classifications required by roofing-specialty manufacturer for each application.

2.6 FINISHES

A. Coil-Coated Galvanized-Steel Sheet Finishes:

a. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat.

PART 3 - EXECUTION (Not Applicable)

3.1 INSTALLATION, GENERAL

A. General: Install roof specialties according to manufacturer's written instructions. Anchor roof specialties securely in place, with provisions for thermal and structural movement. Use fasteners, solder, protective coatings, separators, underlayments, sealants, and other miscellaneous items as required to complete roof-specialty systems.

1. Install roof specialties level, plumb, true to line and elevation; with limited oil-canning and without warping, jogs in alignment, buckling, or tool marks.
2. Provide uniform, neat seams with minimum exposure of solder and sealant.
3. Install roof specialties to fit substrates and to result in weathertight performance. Verify shapes and dimensions of surfaces to be covered before manufacture.
4. Torch cutting of roof specialties is not permitted.
5. Do not use graphite pencils to mark metal surfaces.

B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.

1. Coat concealed side of roof specialties with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.
2. Bed flanges in thick coat of asphalt roofing cement where required by manufacturers of roof specialties for waterproof performance.

C. Expansion Provisions: Allow for thermal expansion of exposed roof specialties.

1. Space movement joints at a maximum of 12 feet with no joints within 18 inches of corners or intersections unless otherwise indicated on Drawings.
2. When ambient temperature at time of installation is between 40 and 70 deg F, set joint members for 50 percent movement each way. Adjust setting proportionately for installation at higher ambient temperatures.

D. Fastener Sizes: Use fasteners of sizes that penetrate substrate not less than recommended by fastener manufacturer to achieve maximum pull-out resistance.

E. Seal concealed joints with butyl sealant as required by roofing-specialty manufacturer.

F. Seal joints as required for weathertight construction. Place sealant to be completely concealed in joint. Do not install sealants at temperatures below 40 deg F.

G. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Pre-tin edges of sheets to be soldered to a width of 1-1/2 inches; however, reduce pre-tinning where pre-tinned surface would show in completed Work. Tin edges of uncoated copper sheets using solder for copper. Do not use torches for soldering. Heat surfaces to receive solder and flow solder into joint. Fill joint completely. Completely remove flux and spatter from exposed surfaces.

## 3.2 ROOF-EDGE SPECIALITIES INSTALLATION

A. Install cleats, cants, and other anchoring and attachment accessories and devices with concealed fasteners.

B. Anchor roof edgings with manufacturer's required devices, fasteners, and fastener spacing to meet performance requirements.

## 3.3 ROOF-EDGE DRAINAGE-SYSTEM INSTALLATION

A. General: Install components to produce a complete roof-edge drainage system according to manufacturer's written instructions. Coordinate installation of roof perimeter flashing with installation of roof-edge drainage system.

B. Gutters: Join and seal gutter lengths. Allow for thermal expansion. Attach gutters to firmly anchored gutter supports spaced not more than 12 inches apart. Attach ends with rivets and seal with sealant to make watertight. Slope to downspouts.

1. Install gutter with expansion joints at locations indicated but not exceeding 50 feet apart. Install expansion-joint caps.

C. Downspouts: Join sections with manufacturer's standard telescoping joints. Provide hangers with fasteners designed to hold downspouts securely to walls and 1 inch away from walls; locate fasteners at top and bottom and at approximately 60 inches o.c.
1. Connect downspouts to underground drainage system indicated.

## 3.4 CLEANING AND PROTECTION

A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.

B. Clean and neutralize flux materials. Clean off excess solder and sealants.

C. Remove temporary protective coverings and strippable films as roof specialties are installed.

END OF SECTION 077100

# SECTION 077253 - SNOW GUARDS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Rail-type, seam-mounted snow guards.

### 1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include roof plans showing layouts and attachment details of snow guards.

1. Include details of rail-type snow guards.

C. Samples:

1. Rail-Type Snow Guards: Bracket and 12-inch-long rail.

a. For units with factory-applied finishes, submit manufacturer's standard color selections.

D. Delegated-Design Submittal: For snow guards, include analysis reports signed and sealed by the qualified professional engineer responsible for their preparation.

1. Include calculation of number and location of snow guards.

### 1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For professional engineer's experience with providing delegated design engineering services of the kind indicated, including documentation that the engineer is licensed in the state in which the Project is located.

B. Product Test Reports: For each type of snow guard, for tests performed by a qualified testing agency, indicating point of failure of attachment to roof system identical as that used on this Project.

PART 2 - PRODUCTS

## 2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design snow guards, including attachment to building, based on the following:

1. Roof snow load.
2. Snow drifting
3. Roof slope.
4. Roof type.
5. Roof dimensions.
6. Roofing substrate type and thickness.
7. Snow guard type.
8. Snow guard fastening method and strength.
9. Snow guard spacing.
10. Coefficient of Friction Between Snow and Roof Surface: 0.
11. Factor of Safety: 2.

B. Performance Requirements: Provide snow guards that withstand exposure to weather and resist thermally induced movement without failure, rattling, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

C. Structural Performance: Snow guards shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated.

1. Snow Loads: As indicated on Structural Drawings.

## 2.2 RAIL-TYPE SNOW GUARDS

A. Seam-Mounted, Rail-Type Snow Guards:
1. Description: Snow guard rails fabricated from metal pipes, bars, or extrusions, anchored to brackets and equipped with one rail with integral track to accept color-matching inserts of material and finish used for metal roof.
2. Material and Finish: Aluminum; clear anodized.
3. Seam clamps: ASTM B 221 aluminum extrusion or ASTM B 85/B 85M aluminum casting with stainless steel set screws incorporating round nonpenetrating point; designed for use with applicable roofing system to which clamp is attached.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install snow guards according to manufacturer's written instructions.

1. Space rows as indicated on Shop Drawings.
2. Space rows as recommended by manufacturer.

B. Attachment for Standing-Seam Metal Roofing:

1. Do not use fasteners that will penetrate metal roofing or fastening methods that void metal roofing finish warranty.

2. Seam-Mounted, Rail-Type Snow Guards:

a. Install brackets to vertical ribs in straight rows.
b. Secure with stainless steel set screws, incorporating round nonpenetrating point, on same side of standing seam.
c. Torque set screw according to manufacturer's instructions.
d. Install cross members to brackets.

END OF SECTION 077253

# SECTION 078413 - PENETRATION FIRESTOPPING

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Penetrations in fire-resistance-rated walls.
2. Penetrations in horizontal assemblies.

### 1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Product Schedule: For each penetration firestopping system. Include location, illustration of firestopping system, and design designation of qualified testing and inspecting agency.

1. Engineering Judgments: Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping system, submit illustration, with modifications marked, approved by penetration firestopping system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly. Obtain approval of authorities having jurisdiction prior to submittal.

### 1.3 INFORMATIONAL SUBMITTALS

A. Product test reports.

### 1.4 CLOSEOUT SUBMITTALS

A. Installer Certificates: From Installer indicating that penetration firestopping systems have been installed in compliance with requirements and manufacturer's written instructions.

### 1.5 QUALITY ASSURANCE

A. Installer Qualifications: A firm that has been approved by FM Global according to FM Global 4991, "Approval of Firestop Contractors," or been evaluated by UL and found to comply with its "Qualified Firestop Contractor Program Requirements."

PART 2 - PRODUCTS

## 2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics:

1. Perform penetration firestopping system tests by a qualified testing agency acceptable to authorities having jurisdiction.
2. Test per testing standards referenced in "Penetration Firestopping Systems" Article. Provide rated systems complying with the following requirements:

a. Penetration firestopping systems shall bear classification marking of a qualified testing agency.

1) UL in its "Fire Resistance Directory."

## 2.2 PENETRATION FIRESTOPPING SYSTEMS

A. Penetration Firestopping Systems: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration firestopping systems shall be compatible with one another, with the substrates forming openings, and with penetrating items if any.

B. Penetrations in Fire-Resistance-Rated Walls: Penetration firestopping systems with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.

1. F-Rating: Not less than the fire-resistance rating of constructions penetrated.

C. Penetrations in Horizontal Assemblies: Penetration firestopping systems with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.

1. F-Rating: At least one hour, but not less than the fire-resistance rating of constructions penetrated.
2. T-Rating: At least one hour, but not less than the fire-resistance rating of constructions penetrated except for floor penetrations within the cavity of a wall.
3. W-Rating: Provide penetration firestopping systems showing no evidence of water leakage when tested according to UL 1479.

D. Exposed Penetration Firestopping Systems: Flame-spread and smoke-developed indexes of less than 25 and 450, respectively, per ASTM E 84.

E. Accessories: Provide components for each penetration firestopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration firestopping system manufacturer and approved by qualified testing and inspecting agency for conditions indicated.

PART 3 - EXECUTION

## 3.1 INSTALLATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of the Work.

B. General: Install penetration firestopping systems to comply with manufacturer's written installation instructions and published drawings for products and applications.

C. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings.

1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not forming permanent components of firestopping.

D. Install fill materials by proven techniques to produce the following results:

1. Fill voids and cavities formed by openings, forming materials, accessories and penetrating items to achieve required fire-resistance ratings.
2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

## 3.2 FIELD QUALITY CONTROL

A. Owner will engage a qualified testing agency to perform tests and inspections according to ASTM E 2174.

B. Where deficiencies are found or penetration firestopping system is damaged or removed because of testing, repair or replace penetration firestopping system to comply with requirements.

C. Proceed with enclosing penetration firestopping systems with other construction only after inspection reports are issued and installations comply with requirements.

END OF SECTION 078413

# SECTION 078446 - FIRE-RESISTIVE JOINT SYSTEMS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:

1. Joints in or between fire-resistance-rated constructions.
2. Joints in smoke barriers.

### 1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Qualification Data: For qualified Installer.

C. Installer Certificates: From Installer indicating fire-resistive joint systems have been installed in compliance with requirements and manufacturer's written recommendations.

D. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for fire-resistive joint systems.

### 1.4 QUALITY ASSURANCE

A. Installer Qualifications: A firm experienced in installing fire-resistive joint systems similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance. Qualifications include having the necessary experience, staff, and training to install manufacturer's products per specified requirements. Manufacturer's willingness to sell its fire-resistive joint system products to Contractor or to Installer engaged by Contractor does not in itself confer qualification on buyer.

B. Fire-Test-Response Characteristics: Fire-resistive joint systems shall comply with the following requirements:

1. Fire-resistive joint system tests are performed by a qualified testing agency acceptable to authorities having jurisdiction.
2. Fire-resistive joint systems are identical to those tested per testing standard referenced in "Fire-Resistive Joint Systems" Article. Provide rated systems complying with the following requirements:

    a. Fire-resistive joint system products bear classification marking of qualified testing agency.
    b. Fire-resistive joint systems correspond to those indicated by reference to designations listed by the following:

        1) UL in its "Fire Resistance Directory."

C. Preinstallation Conference: Conduct conference at Project site.

1.5 PROJECT CONDITIONS

A. Environmental Limitations: Do not install fire-resistive joint systems when ambient or substrate temperatures are outside limits permitted by fire-resistive joint system manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.

B. Install and cure fire-resistive joint systems per manufacturer's written instructions using natural means of ventilation or, where this is inadequate, forced-air circulation.

1.6 COORDINATION

A. Coordinate construction of joints to ensure that fire-resistive joint systems are installed according to specified requirements.

B. Coordinate sizing of joints to accommodate fire-resistive joint systems.

C. Notify Owner's testing agency at least seven days in advance of fire-resistive joint system installations; confirm dates and times on day preceding each series of installations.

**PART 2 - PRODUCTS**

2.1 FIRE-RESISTIVE JOINT SYSTEMS

A. Where required, provide fire-resistive joint systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of assemblies in or between

which fire-resistive joint systems are installed. Fire-resistive joint systems shall accommodate building movements without impairing their ability to resist the passage of fire and hot gases.

B. Joints in or between Fire-Resistance-Rated Construction: Provide fire-resistive joint systems with ratings determined per ASTM E 1966 or UL 2079:

1. Joints include those installed in or between fire-resistance-rated walls, floor or floor/ceiling assemblies, and roofs or roof/ceiling assemblies.
2. Fire-Resistance Rating: Equal to or exceeding the fire-resistance rating of construction they will join.
3. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. A/D Fire Protection Systems Inc.
    b. Grace Construction Products.
    c. Hilti, Inc.
    d. Nelson Firestop Products.
    e. NUCO Inc.
    f. Specified Technologies Inc.
    g. 3M Fire Protection Products.
    h. Tremco, Inc.; Tremco Fire Protection Systems Group.
    i. USG Corporation.

C. Joints in Smoke Barriers: Provide fire-resistive joint systems with ratings determined per UL 2079.

1. L-Rating: Not exceeding 5.0 cfm/ft of joint at 0.30 inch wg at both ambient and elevated temperatures.
2. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. A/D Fire Protection Systems Inc.
    b. Grace Construction Products.
    c. Hilti, Inc.
    d. Nelson Firestop Products.
    e. NUCO Inc.
    f. Specified Technologies Inc.
    g. 3M Fire Protection Products.
    h. Tremco, Inc.; Tremco Fire Protection Systems Group.
    i. USG Corporation.

D. Exposed Fire-Resistive Joint Systems: Provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.

E. Accessories: Provide components of fire-resistive joint systems, including primers and forming materials, that are needed to install fill materials and to maintain ratings required. Use only components specified by fire-resistive joint system manufacturer and approved by the qualified testing agency for systems indicated.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for joint configurations, substrates, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

A. Surface Cleaning: Clean joints immediately before installing fire-resistive joint systems to comply with fire-resistive joint system manufacturer's written instructions and the following requirements:

1. Remove from surfaces of joint substrates foreign materials that could interfere with adhesion of fill materials.
2. Clean joint substrates to produce clean, sound surfaces capable of developing optimum bond with fill materials. Remove loose particles remaining from cleaning operation.
3. Remove laitance and form-release agents from concrete.

B. Priming: Prime substrates where recommended in writing by fire-resistive joint system manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

C. Masking Tape: Use masking tape to prevent fill materials of fire-resistive joint system from contacting adjoining surfaces that will remain exposed on completion of the Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove stains. Remove tape as soon as possible without disturbing fire-resistive joint system's seal with substrates.

### 3.3 INSTALLATION

A. General: Install fire-resistive joint systems to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.

B. Install forming materials and other accessories of types required to support fill materials during their application and in position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.

1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of fire-resistive joint system.

C. Install fill materials for fire-resistive joint systems by proven techniques to produce the following results:

1. Fill voids and cavities formed by joints and forming materials as required to achieve fire-resistance ratings indicated.
2. Apply fill materials so they contact and adhere to substrates formed by joints.
3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

## 3.4 IDENTIFICATION

A. Identify fire-resistive joint systems with preprinted metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches of joint edge so labels will be visible to anyone seeking to remove or penetrate joint system. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:

1. The words "Warning - Fire-Resistive Joint System - Do Not Disturb. Notify Building Management of Any Damage."
2. Contractor's name, address, and phone number.
3. Designation of applicable testing agency.
4. Date of installation.
5. Manufacturer's name.
6. Installer's name.

B. Wall Identification: Permanently label walls containing fire-resistive joint systems with the words “FIRE AND/OR SMOKE BARRIER – PROTECT ALL OPENINGS”, using lettering not less than 3 inches high and with minimum 0.375-inch strokes.

1. Locate in accessible concealed floor, floor-ceiling, or attic space at 15 feet from end of wall and at intervals not exceeding 30 feet.

## 3.5 FIELD QUALITY CONTROL

A. Inspecting Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Where deficiencies are found or fire-resistive joint systems are damaged or removed due to testing, repair or replace fire-resistive joint systems so they comply with requirements.

C. Proceed with enclosing fire-resistive joint systems with other construction only after inspection reports are issued and installations comply with requirements.

## 3.6 CLEANING AND PROTECTING

A. Clean off excess fill materials adjacent to joints as the Work progresses by methods and with cleaning materials that are approved in writing by fire-resistive joint system manufacturers and that do not damage materials in which joints occur.

B. Provide final protection and maintain conditions during and after installation that ensure fire-resistive joint systems are without damage or deterioration at time of Substantial Completion. If damage or deterioration occurs despite such protection, cut out and remove damaged or deteriorated fire-resistive joint systems immediately and install new materials to produce fire-resistive joint systems complying with specified requirements.

END OF SECTION 078446

# SECTION 079200 - JOINT SEALANTS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Silicone joint sealants.
2. Mildew-resistant joint sealants.
3. Latex joint sealants.

### 1.2 ACTION SUBMITTALS

A. Product Data: For each joint-sealant product.

B. Samples: For each kind and color of joint sealant required.

C. Joint-Sealant Schedule: Include the following information:

1. Joint-sealant application, joint location, and designation.
2. Joint-sealant manufacturer and product name.
3. Joint-sealant formulation.
4. Joint-sealant color.

### 1.3 INFORMATIONAL SUBMITTALS

A. Product test reports.

B. Preconstruction laboratory test reports.

C. Preconstruction field-adhesion-test reports.

D. Field-adhesion-test reports.

E. Sample warranties.

### 1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM C 1021 to conduct the testing indicated.

1.5 PRECONSTRUCTION TESTING

A. Preconstruction Laboratory Testing: Submit to joint-sealant manufacturers, for testing indicated below, samples of materials that will contact or affect joint sealants.

1. Adhesion Testing: Use ASTM C 794 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
2. Compatibility Testing: Use ASTM C 1087 to determine sealant compatibility when in contact with glazing and gasket materials.
3. Stain Testing: Use ASTM C 1248 to determine stain potential of sealant when in contact with masonry substrates.

B. Preconstruction Field-Adhesion Testing: Before installing sealants, field test their adhesion to Project joint substrates. Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1.1 in ASTM C 1193 or Method A, Tail Procedure, in ASTM C 1521.

1.6 WARRANTY

A. Special Installer's Warranty: Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

B. Special Manufacturer's Warranty: Manufacturer agrees to furnish joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 JOINT SEALANTS, GENERAL

A. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.2 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials.

C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

## PART 3 - EXECUTION

### 3.1 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:

1. Remove laitance and form-release agents from concrete.
2. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion.

B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience.

C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces.

### 3.2 INSTALLATION OF JOINT SEALANTS

A. General: Comply with ASTM C 1193 and joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

B. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

C. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

D. Install sealants using proven techniques that comply with the following and at the same time backings are installed:

1. Place sealants so they directly contact and fully wet joint substrates.
2. Completely fill recesses in each joint configuration.
3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

E. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants to form smooth, uniform beads of configuration indicated. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.

1. Provide concave joint profile per Figure 8A in ASTM C 1193 unless otherwise indicated.

3.3 FIELD QUALITY CONTROL

A. Evaluation of Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

3.4 JOINT-SEALANT SCHEDULE

A. Joint-Sealant Application: Exterior joints in vertical surfaces and horizontal nontraffic surfaces[ ].

1. Joint Locations:
   a. Control and expansion joints in unit masonry.
   b. Other joints as indicated on Drawings.

2. Joint Sealant: Silicone, nonstaining, S, NS, 50, NT.
3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

B. Joint-Sealant Application: Mildew-resistant interior joints in vertical surfaces and horizontal nontraffic surfaces[ ].

1. Joint Locations:

   a. Joints between plumbing fixtures and adjoining walls, floors, and counters.
   b. Other joints as indicated on Drawings.

2. Joint Sealant: Silicone, mildew resistant, acid curing, S, NS, 25, NT.
3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

END OF SECTION 079200

# SECTION 081113 - HOLLOW METAL DOORS AND FRAMES

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section includes:

1. Interior standard steel doors and frames.
2. Exterior standard steel doors and frames.
3. Interior custom hollow-metal doors and frames. (Doors 14 & 28, interior double doors at hoistway)

### 1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include the following:

1. Elevations of each door type.
2. Details of doors, including vertical- and horizontal-edge details and metal thicknesses.
3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.

C. Product Schedule: For hollow-metal doors and frames, prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with final door hardware schedule.

### 1.4 INFORMATIONAL SUBMITTALS

A. Product test reports.

B. Field quality control reports.

### 1.5 CLOSEOUT SUBMITTALS

A. Record Documents: For fire-rated doors, list of door numbers and applicable room name and number to which door accesses.

1.6 QUALITY ASSURANCE

A. Fire-Rated Door Inspector Qualifications: Inspector for field quality control inspections of fire-rated door assemblies shall meet the qualifications set forth in NFPA 80, Section 5.2.3.1 and the following:

1. Door and Hardware Institute Fire and Egress Door Assembly Inspector (FDAI) certification.

B. Egress Door Inspector Qualifications: Inspector for field quality control inspections of egress door assemblies shall meet the qualifications set forth in NFPA 101, Section 7.2.1.15.4 and the following:

1. Door and Hardware Institute Fire and Egress Door Assembly Inspector (FDAI) certification.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Rated, Borrowed-Lite Assemblies: Assemblies complying with NFPA 80 and listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 257 or UL 9.

B. Thermally Rated Door Assemblies: Provide door assemblies with U-factor of not more than 0.50 deg Btu/F x h x sq. ft. 0.40 deg Btu/F x h x sq. ft. when tested according to ASTM C518.

2.2 INTERIOR STANDARD STEEL DOORS AND FRAMES

A. Construct hollow-metal doors and frames to comply with standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.

B. Standard-Duty Doors and Frames: ANSI/SDI A250.8, Level 1; ANSI/SDI A250.4, Level C. At locations indicated in the Door and Frame Schedule.

1. Doors:

a. Type: As indicated in the Door and Frame Schedule.
b. Thickness: 1-3/4 inches.
c. Face: Uncoated steel sheet, minimum thickness of 16 ga.
d. Edge Construction: Model 1, Full Flush.
e. Core: Manufacturer's standard.
f. Fire-Rated Core: Manufacturer's standard vertical steel stiffener core for fire-rated doors.

2. Frames:

a. Materials: Uncoated steel sheet, minimum thickness of 16 ga.
b. Construction: Knocked down.

## 2.3 EXTERIOR STANDARD STEEL DOORS AND FRAMES

A. Construct hollow-metal doors and frames to comply with standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.

B. Heavy-Duty Doors and Frames: ANSI/SDI A250.8, Level 2; ANSI/SDI A250.4, Level B. At locations indicated in the Door and Frame Schedule.

1. Doors:

a. Type: As indicated in the Door and Frame Schedule.
b. Thickness: 1-3/4 inches.
c. Face: Metallic-coated steel sheet, minimum thickness of 16 ga.
d. Edge Construction: Model 1, Full Flush.
e. Edge Bevel: Provide manufacturer's standard beveled or square edges.
f. Bottom Edges: Close bottom edges of doors where required for attachment of weather stripping with end closures or channels of same material as face sheets. Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape.
g. Core: Manufacturer's standard.
h. Fire-Rated Core: Manufacturer's standard vertical steel stiffener with insulation core for fire-rated doors.

2. Frames:

a. Materials: Metallic-coated steel sheet, minimum thickness of 16 ga.
b. Construction: Face welded.

## 2.4 INTERIOR CUSTOM HOLLOW-METAL DOORS AND FRAMES

A. Hollow-Metal Doors and Frames: NAAMM-HMMA 860; ANSI/SDI A250.4, Physical Performance Level A. At locations indicated in the Door and Frame Schedule.

1. Doors: (Doors 14 & 28, interior double doors at hoistway. 8 foot tall doors)

a. Type: As indicated in the Door and Frame Schedule.
b. Thickness: 1-3/4 inches.
c. Face: Uncoated steel sheet, minimum thickness of 14 ga..
d. Edge Construction: Continuously welded with no visible seam.
e. Core: Steel stiffened.
f. Fire-Rated Core: Manufacturer's standard vertical steel stiffener core for fire-rateddoors.

2. Frames:

a. Materials: Uncoated steel sheet, minimum thickness of 14 ga.
b. Construction: Knocked down.

## 2.5 FRAME ANCHORS

A. Jamb Anchors:

1. Type: Anchors of minimum size and type required by applicable door and frame standard, and suitable for performance level indicated.
2. Quantity: Minimum of three anchors per jamb, with one additional anchor for frames with no floor anchor. Provide one additional anchor for each 24 inches of frame height above 7 feet.
3. Postinstalled Expansion Anchor: Minimum 3/8-inch-diameter bolts with expansion shields or inserts, with manufacturer's standard pipe spacer.

B. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor.

C. Floor Anchors for Concrete Slabs with Underlayment: Adjustable-type anchors with extension clips, allowing not less than 2-inch height adjustment. Terminate bottom of frames at top of underlayment.

D. Material: ASTM A879/A879M, Commercial Steel (CS), 04Z coating designation; mill phosphatized.

1. For anchors built into exterior walls, steel sheet complying with ASTM A1008/A1008M or ASTM A1011/A1011M; hot-dip galvanized according to ASTM A153/A153M, Class B.

## 2.6 MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Commercial Steel (CS), Type B; suitable for exposed applications.

B. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.

C. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B.

D. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A153/A153M.

E. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow-metal frames of type indicated.

F. Mineral-Fiber Insulation: ASTM C665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E136 for combustion characteristics.

## 2.7 FABRICATION

A. Door Astragals: Provide overlapping astragal on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated. Extend minimum 3/4 inch beyond edge of door on which astragal is mounted or as required to comply with published listing of qualified testing agency.

B. Hollow-Metal Frames: Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections, provide alignment plates or angles at each joint, fabricated of metal of same or greater thickness as frames.
   1. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
   2. Door Silencers: Except on weather-stripped frames, drill stops to receive door silencers as follows. Keep holes clear during construction.

      a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
      b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.

C. Hardware Preparation: Factory prepare hollow-metal doors and frames to receive templated mortised hardware, and electrical wiring; include cutouts, reinforcement, mortising, drilling, and tapping according to ANSI/SDI A250.6, the Door Hardware Schedule, and templates.

   1. Reinforce doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.
   2. Comply with BHMA A156.115 for preparing hollow-metal doors and frames for hardware.

D. Glazed Lites: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with mitered hairline joints.

   1. Provide stops and moldings flush with face of door, and with beveled stops unless otherwise indicated.
   2. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames. Provide loose stops and moldings on inside of hollow-metal doors and frames.
   3. Coordinate rabbet width between fixed and removable stops with glazing and installation types indicated.
   4. Provide stops for installation with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches o.c. and not more than 2 inches o.c. from each corner.

## 2.8 STEEL FINISHES

A. Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.

   1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with ANSI/SDI A250.10; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

PART 3 - EXECUTION

3.1 PREPARATION

A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces. Touch up factory-applied finishes where spreaders are removed.

B. Drill and tap doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.

3.2 INSTALLATION

A. Hollow-Metal Frames: Comply with ANSI/SDI A250.11.

1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces without damage to completed Work.

    a. Where frames are fabricated in sections, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces. Touch-up finishes.
    b. Install frames with removable stops located on secure side of opening.

2. Fire-Rated Openings: Install frames according to NFPA 80.
3. Floor Anchors: Secure with postinstalled expansion anchors.

    a. Floor anchors may be set with power-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.

4. Solidly pack mineral-fiber insulation inside frames.
5. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout or mortar.
6. In-Place Concrete or Masonry Construction: Secure frames in place with postinstalled expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
7. Installation Tolerances: Adjust hollow-metal frames to the following tolerances:

    a. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
    b. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
    c. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
    d. Plumbness: Plus or minus 1/16 inch, measured at jambs at floor.

B. Hollow-Metal Doors: Fit and adjust hollow-metal doors accurately in frames, within clearances specified below.

1. Non-Fire-Rated Steel Doors: Comply with ANSI/SDI A250.8.
2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.

3.3 REPAIR

A. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.

B. Metallic-Coated Surface Touchup: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.

C. Touchup Painting: Cleaning and touchup painting of abraded areas of paint are specified in painting Sections.

END OF SECTION 081113

# SECTION 083113 - ACCESS DOORS AND FRAMES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section includes access doors and frames for ceilings. (attic access)

### 1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each type of access door and frame and for each finish specified.

### 1.3 CLOSEOUT SUBMITTALS

A. Record Documents: For fire-rated doors, list of applicable room name and number in which access door is located.

### 1.4 QUALITY ASSURANCE

A. Fire-Rated Door Inspector Qualifications: Inspector for field quality control inspections of fire-rated door assemblies shall meet the qualifications set forth in NFPA 80, section 5.2.3.1 and the following:

1. Door and Hardware Institute Fire and Egress Door Assembly Inspector (FDAI) certification.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

A. Fire-Rated Access Doors and Frames: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection and temperature-rise limit ratings indicated, according to NFPA 252 or UL 10B.

### 2.2 ACCESS DOORS AND FRAMES

A. Flush Access Doors with Exposed Flanges:

1. Description: Face of door flush with frame, with exposed flange and concealed hinge.
2. Locations: Ceiling.

3. Uncoated Steel Sheet for Door: Nominal 0.060 inch, 16 gage, factory finished.
4. Frame Material: Same material, thickness, and finish as door.
5. Latch and Lock: Cam latch, screwdriver operated.

## 2.3 MATERIALS

A. Steel Plates, Shapes, and Bars: ASTM A36/A36M.

B. Steel Sheet: Uncoated or electrolytic zinc coated, ASTM A879/A879M, with cold-rolled steel sheet substrate complying with ASTM A1008/A1008M, Commercial Steel (CS), exposed.

C. Frame Anchors: Same material as door face.

D. Inserts, Bolts, and Anchor Fasteners: Hot-dip galvanized steel according to ASTM A153/A153M or ASTM F2329.

## 2.4 FABRICATION

A. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.

B. Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish mounting holes, attachment devices and fasteners of type required to secure access doors to types of supports indicated.

C. Latch and Lock Hardware:

1. Quantity: Furnish number of latches and locks required to hold doors tightly closed.
2. Keys: Furnish two keys per lock and key all locks alike.

## 2.5 FINISHES

A. Painted Finishes: Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

1. Factory Primed: Apply manufacturer's standard, lead- and chromate-free, universal primer immediately after surface preparation and pretreatment.
2. Factory Finished: Apply manufacturer's standard baked-enamel or powder-coat finish immediately after cleaning and pretreating, with minimum dry-film thickness of 1 mil for topcoat.

a. Color: As selected by Architect from full range of industry colors.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with manufacturer's written instructions for installing access doors and frames.

B. Adjust doors and hardware, after installation, for proper operation.

3.2 FIELD QUALITY CONTROL

A. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.

B. Reinspect repaired or replaced installations to determine if replaced or repaired door assembly installations comply with specified requirements.

END OF SECTION 083113

# SECTION 083613 – GLAZED ALUMINUM SECTIONAL DOORS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section includes manually operated sectional doors.

B. Insulate door glass and track to meet IECC C402.5.2 air infiltration requirements.

C. Related Requirements:

1. Section 055000 "Metal Fabrications" for miscellaneous steel supports.

### 1.2 ACTION SUBMITTALS

A. Product Data: For each type and size of sectional door and accessory.

B. Shop Drawings: For each installation and for special components not dimensioned or detailed in manufacturer's product data.

C. Samples: For each exposed product and for each color and texture specified.

### 1.3 INFORMATIONAL SUBMITTALS

A. Sample warranty.

### 1.4 CLOSEOUT SUBMITTALS

A. Maintenance data.

### 1.5 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer for both installation and maintenance of units required for this Project.

### 1.6 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of sectional doors that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

B. Special Finish Warranty: Manufacturer agrees to repair or replace components that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Warranty Period: 2 years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Sectional doors shall comply with performance requirements specified without failure due to defective manufacture, fabrication, installation, or other defects in construction and without requiring temporary installation of reinforcing components.

B. Structural Performance, Exterior Doors: Capable of withstanding the design wind loads.

1. Design Wind Load: As indicated on the Structural Drawings.
2. Testing: According to ASTM E330 or DASMA 108 for garage doors and complying with the acceptance criteria of DASMA 108.

C. Seismic Performance: Sectional doors shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

### 2.2 DOOR ASSEMBLY

A. Glazed Sectional Door: Sectional door formed with hinged sections and fabricated according to DASMA 102 unless otherwise indicated.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Glazed Aluminum Overhead Door with vertical track.
1) Overhead Door Corporation. Modern Aluminum Door 521 Series.

B. Operation Cycles: Door components and operators capable of operating for not less than 10,000.

C. Air Infiltration: Maximum rate of 0.4 cfm/sq. ft. at 25 mph when tested according to ASTM E283. Include insulated rails and stiles.

D. R-Value: 4.5 deg F x h x sq. ft./Btu.

E. Glazed Sections: Manufacturer's standard. ½" Thick, Low-E, Tempered, Insulating glass.

F. Track Configuration: Vertical-lift track.

G. Weatherseals: Fitted to bottom and top and around entire perimeter of door. Provide combination bottom weatherseal and sensor edge.

H. Locking Devices: Equip door with slide bolt for padlock.

I. Manual Door Operator: Push-up operation.

J. Door Finish:

1. Aluminum Finish: Clear anodized.

## 2.3 GLAZED DOOR SECTIONS

A. Sections: Extruded-aluminum stile and rail members with dimensions and profiles as indicated on Drawings; and with overlapped or interlocked weather-resistant seal at meeting rails.

1. Reinforce or form trusses within sections as required to stiffen door and for wind loading.
2. Provide reinforcement for hardware attachment.

B. Glazed Panels: secured and sealed watertight to framing, and reinforced to comply with performance requirements.

C. ½" Thick, Low-E, Tempered, Insulating glass.

## 2.4 TRACKS, SUPPORTS, AND ACCESSORIES

A. Tracks: Manufacturer's standard, galvanized-steel track system of configuration indicated, sized for door size and weight, designed for lift type indicated and clearances indicated on Drawings, Provide complete system including brackets, bracing, and reinforcement to ensure rigid support of ball-bearing roller guides for required door type, size, weight, and loading.

1. Track Reinforcement and Supports: Galvanized-steel members to support track without sag, sway, and vibration during opening and closing of doors. Slot vertical sections of track spaced 2 inches apart for door-drop safety device.

2. Mount track to surface-mounted preservative treated wood ledgers as indicated in the Architectural drawings. Anchor ledger to grouted cmu cells.

B. Weatherseals: Replaceable, adjustable, continuous, compressible weather-stripping gaskets of flexible vinyl, rubber, or neoprene fitted to bottom and top of sectional door unless otherwise indicated.

## 2.5 HARDWARE

A. General: Heavy-duty, corrosion-resistant hardware, with hot-dip galvanized, stainless-steel, or other corrosion-resistant fasteners, to suit door type.

B. Hinges: Heavy-duty, galvanized-steel hinges at each end stile and at each intermediate stile, according to manufacturer's written recommendations for door size. Attach hinges to door sections through stiles and rails.

C. Rollers: Heavy-duty rollers with steel ball-bearings in case-hardened steel races, mounted with varying projections to suit slope of track. Provide 3-inch-diameter roller tires for 3-inch-wide track and 2-inch-diameter roller tires for 2-inch-wide track.

D. Push/Pull Handles: Equip each push-up operated or emergency-operated door with galvanized-steel lifting handles on each side of door, finished to match door.

## 2.6 LOCKING DEVICES

A. Slide Bolt: Fabricate with side-locking bolts to engage through slots in tracks for locking by padlock, located on single-jamb side, operable from inside only.

## 2.7 COUNTERBALANCE MECHANISM

A. Torsion Spring: Counterbalance mechanism consisting of adjustable-tension torsion springs fabricated from steel-spring wire complying with ASTM A229/A229M, mounted on torsion shaft made of steel tube or solid steel. Provide springs designed for number of operation cycles indicated.

B. Cables: Galvanized-steel, multistrand, lifting cables.

C. Bracket: Provide anchor support bracket as required to connect stationary end of spring to the wall and to level the shaft and prevent sag.

D. Bumper: Provide spring bumper at each horizontal track to cushion door at end of opening operation.

## 2.8 MANUAL DOOR OPERATORS

A. General: Equip door with manual door operator by door manufacturer.

B. Push-up Operation: Lift handles and pull rope for raising and lowering doors, with counterbalance mechanism designed so that required lift or pull for door operation does not exceed 25 lbf.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

A. Install sectional doors and operating equipment complete with necessary hardware, anchors, inserts, hangers, and equipment supports; according to manufacturer's written instructions and as specified.

B. Tracks: Provide sway bracing, diagonal bracing, and reinforcement as required for rigid installation of track and door-operating equipment.

C. Adjust hardware and moving parts to function smoothly so that doors operate easily, free of warp, twist, or distortion.

3.2 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain sectional doors.

END OF SECTION 083613

# SECTION 084113 - ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
1. Storefront framing.
2. Fixed windows.
3. Manual-swing entrance doors.
4. 1” low-E insulating glass.

### 1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For aluminum-framed entrances and storefronts. Include plans, elevations, sections, full-size details, and attachments to other work.

1. Show connection to and continuity with adjacent thermal, weather, air, and vapor barriers.

C. Samples: For each type of exposed finish required.

D. Entrance Door Hardware Schedule: Prepared by or under supervision of supplier, detailing fabrication and assembly of entrance door hardware, as well as procedures and diagrams.

E. Delegated-Design Submittal: For aluminum-framed entrances and storefronts indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

### 1.3 INFORMATIONAL SUBMITTALS

A. Energy Performance Certificates: NFRC-certified energy performance values from manufacturer.

B. Product test reports.

C. Source quality-control reports.

D. Field quality-control reports.

E. Sample warranties.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

B. Testing Agency Qualifications: Qualified according to ASTM E699 for testing indicated and accredited by the International Accreditation Service or the International Laboratory Accreditation Cooperation Mutual Recognition Arrangement as complying with ISO/IEC 17025.

C. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.

1. Do not change intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If changes are proposed, submit comprehensive explanatory data to Architect for review.

1.6 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of aluminum-framed entrances and storefronts that do not comply with requirements or that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

B. Special Finish Warranty: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of factory-applied finishes within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

C. Glazing: double glazed with a 10 year guaranteed vacuum -seal.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design aluminum-framed entrances and storefronts.

B. General Performance: Comply with performance requirements specified, as determined by testing of aluminum-framed entrances and storefronts representing those indicated for this

Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.

1. Aluminum-framed entrances and storefronts shall withstand movements of supporting structure, including, but not limited to, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
2. Failure also includes the following:

    a. Thermal stresses transferring to building structure.
    b. Glass breakage.
    c. Noise or vibration created by wind and thermal and structural movements.
    d. Loosening or weakening of fasteners, attachments, and other components.
    e. Failure of operating units.

C. Structural Loads:

1. Wind Loads: As indicated on Structural drawings.

D. Deflection of Framing Members: At design wind pressure, as follows:

1. Deflection Normal to Wall Plane: Limited to edge of glass in a direction perpendicular to glass plane not exceeding 1/175 of the glass edge length for each individual glazing lite or an amount that restricts edge deflection of individual glazing lites to 3/4 inch, whichever is less.
2. Deflection Parallel to Glazing Plane: Limited to 1/360 of clear span or 1/8 inch, whichever is smaller.

    a. Operable Units: Provide a minimum 1/16-inch clearance between framing members and operable units.

E. Structural: Test according to ASTM E330/E330M as follows:

1. When tested at positive and negative wind-load design pressures, storefront assemblies, including entrance doors, do not evidence deflection exceeding specified limits.
2. When tested at 150 percent of positive and negative wind-load design pressures, storefront assemblies, including entrance doors and anchorage, do not evidence material failures, structural distress, or permanent deformation of main framing members exceeding 0.2 percent of span.
3. Test Durations: As required by design wind velocity, but not less than 10 seconds.

F. Air Infiltration: Test according to ASTM E283 for infiltration as follows:

1. Fixed Framing and Glass Area:

    a. Maximum air leakage of 0.06 cfm/sq. ft. at a static-air-pressure differential of 6.2 lbf/sq. ft..

2. Entrance Doors:

    a. Single Doors: Maximum air leakage of 0.5 cfm/sq. ft. at a static-air-pressure differential of 1.57 lbf/sq. ft..

G. Water Penetration under Static Pressure: Test according to ASTM E331 as follows:

1. No evidence of water penetration through fixed glazing and framing areas, including entrance doors, when tested according to a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 8.00 lbf/sq. ft..

2. Exterior windows and masonry openings shall be weather-tested using the Voluntary Specification for Field Testing of Windows and Sliding Doors (AAMA 502-02) test method B.

H. Energy Performance: Certify and label energy performance according to NFRC as follows:

1. Thermal Transmittance (U-factor): Fixed glazing and framing areas as a system shall have U-factor of not more than 0.44 Btu/sq. ft. x h x deg F as determined according to NFRC 100.
2. Condensation Resistance: Fixed glazing and framing areas as a system shall have an NFRC-certified condensation resistance rating of no less than 62 frame and 68 glass as determined according to NFRC 500.

I. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

## 2.2 STOREFRONT SYSTEMS AND FIXED WINDOWS

A. Kawneer Aluminum Storefronts Trifab 451T Framing System

B. Framing Members: Manufacturer's extruded- or formed-aluminum framing members of thickness required and reinforced as required to support imposed loads.

1. Exterior Framing Construction: Thermally broken.
2. Glazing System: Retained mechanically with gaskets on four sides.
3. Finish: Clear anodic finish.
4. Fabrication Method: Field-fabricated stick system.
5. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
6. Steel Reinforcement: As required by manufacturer.

C. Backer Plates: Manufacturer's standard, continuous backer plates for framing members, if not integral, where framing abuts adjacent construction.

D. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.

## 2.3 ENTRANCE DOOR SYSTEMS

A. Kawneer Aluminum Storefronts Trifab 451T Framing System

B. Entrance Doors: Manufacturer's standard glazed entrance doors for manual-swing or automatic operation.

1. Door Construction: 1-3/4-inch overall thickness, with minimum 0.125-inch- thick, extruded-aluminum tubular rail and stile members. Mechanically fasten corners with reinforcing brackets that are deeply penetrated and fillet welded or that incorporate concealed tie rods.

2. Door Design: Medium stile; 3-1/2-inch nominal width.
3. Glazing Stops and Gaskets: Beveled, snap-on, extruded-aluminum stops and preformed gaskets.

a. Provide nonremovable glazing stops on outside of door.

## 2.4 ENTRANCE DOOR HARDWARE

A. Entrance Door Hardware: Hardware not specified in this Section is specified in Section 087100 "Door Hardware."

B. General: Provide entrance door hardware and entrance door hardware sets indicated in door and frame schedule for each entrance door, to comply with requirements in this Section.

1. Entrance Door Hardware Sets: Provide quantity, item, size, finish or color indicated, and named manufacturers' products.
2. Sequence of Operation: Provide electrified door hardware function, sequence of operation, and interface with other building control systems indicated.
3. Opening-Force Requirements:

a. Egress Doors: Not more than 15 lbf to release the latch and not more than 30 lbf to set the door in motion and not more than 15 lbf to open the door to its minimum required width.
b. Accessible Interior Doors: Not more than 5 lbf to fully open door.

C. Designations: Requirements for design, grade, function, finish, quantity, size, and other distinctive qualities of each type of entrance door hardware are indicated in "Entrance Door Hardware Sets" Article. Products are identified by using entrance door hardware designations as follows:

1. Named Manufacturers' Products: Manufacturer and product designation are listed for each door hardware type required for the purpose of establishing minimum requirements. Manufacturers' names are abbreviated in "Entrance Door Hardware Sets" Article.
2. References to BHMA Standards: Provide products complying with these standards and requirements for description, quality, and function.

D. Cylinders: As specified in Section 087100 "Door Hardware."

E. Pivot Hinges: BHMA A156.4, Grade 1.

1. Offset-Pivot Hinges: Provide top, bottom, and intermediate offset pivots at each door leaf.

F. Cylinders: BHMA A156.5, Grade 1.

1. Keying: Master key system. Permanently inscribe each key with a visual key control number and include notation "DO NOT DUPLICATE".

G. Strikes: Provide strike with black-plastic dust box for each latch or lock bolt; fabricated for aluminum framing.

H. Operating Trim: BHMA A156.6.

I. Closers: BHMA A156.4, Grade 1, with accessories required for a complete installation, sized as required by door size, exposure to weather, and anticipated frequency of use; adjustable to comply with field conditions and requirements for opening force.

J. Door Stops: BHMA A156.16, Grade 1, floor or wall mounted, as appropriate for door location indicated, with integral rubber bumper.

K. Weather Stripping: Manufacturer's standard replaceable components.

1. Compression Type: Made of ASTM D2000 molded neoprene or ASTM D2287 molded PVC.
2. Sliding Type: AAMA 701/702, made of wool, polypropylene, or nylon woven pile with nylon-fabric or aluminum-strip backing.

L. Weather Sweeps: Manufacturer's standard exterior-door bottom sweep with concealed fasteners on mounting strip.

M. Thresholds: BHMA A156.21 raised thresholds beveled with a slope of not more than 1:2, with maximum height of 1/2 inch.

## 2.5 GLAZING

A. Glazing: Comply with Section 088000 "Glazing."

B. Glazing Gaskets: Manufacturer's standard sealed-corner pressure-glazing system of black, resilient elastomeric glazing gaskets, setting blocks, and shims or spacers.

C. Glazing Sealants: As recommended by manufacturer.

D. Glazing shall be clear glass panes, low-e treated, double glazed with a 10 year guaranteed vacuum -seal.

## 2.6 MATERIALS

A. Sheet and Plate: ASTM B209.

B. Extruded Bars, Rods, Profiles, and Tubes: ASTM B221.

C. Extruded Structural Pipe and Tubes: ASTM B429/B429M.

D. Structural Profiles: ASTM B308/B308M.

E. Steel Reinforcement:

1. Structural Shapes, Plates, and Bars: ASTM A36/A36M.
2. Cold-Rolled Sheet and Strip: ASTM A1008/A1008M.
3. Hot-Rolled Sheet and Strip: ASTM A1011/A1011M.
4. Primer: Manufacturer's standard zinc-rich, corrosion-resistant primer complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM, and prepare surfaces according to applicable SSPC standard.

## 2.7 FABRICATION

A. Form or extrude aluminum shapes before finishing.

B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

C. Fabricate components that, when assembled, have the following characteristics:

1. Profiles that are sharp, straight, and free of defects or deformations.
2. Accurately fitted joints with ends coped or mitered.
3. Physical and thermal isolation of glazing from framing members.
4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
5. Provisions for field replacement of glazing from exterior.
6. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.

D. Mechanically Glazed Framing Members: Fabricate for flush glazing without projecting stops.

E. Entrance Door Frames: Reinforce as required to support loads imposed by door operation and for installing entrance door hardware.

F. Entrance Doors: Reinforce doors as required for installing entrance door hardware.

G. Entrance Door Hardware Installation: Factory install entrance door hardware to the greatest extent possible. Cut, drill, and tap for factory-installed entrance door hardware before applying finishes.

H. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

## 2.8 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.

PART 3 - EXECUTION

## 3.1 INSTALLATION

A. General:

1. Comply with manufacturer's written instructions.
2. Do not install damaged components.
3. Fit joints to produce hairline joints free of burrs and distortion.
4. Rigidly secure nonmovement joints.
5. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
6. Seal perimeter and other joints watertight unless otherwise indicated.

B. Metal Protection:

1. Where aluminum is in contact with dissimilar metals, protect against galvanic action by painting contact surfaces with materials recommended by manufacturer for this purpose or by installing nonconductive spacers.
2. Where aluminum is in contact with concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

C. Set continuous sill members and flashing in full sealant bed, as specified in Section 079200 "Joint Sealants," to produce weathertight installation.

D. Install components plumb and true in alignment with established lines and grades.

E. Install operable units level and plumb, securely anchored, and without distortion. Adjust weather-stripping contact and hardware movement to produce proper operation.

F. Install glazing as specified in Section 088000 "Glazing."

G. Entrance Doors: Install doors to produce smooth operation and tight fit at contact points.

1. Exterior Doors: Install to produce weathertight enclosure and tight fit at weather stripping.
2. Field-Installed Entrance Door Hardware: Install surface-mounted entrance door hardware according to entrance door hardware manufacturers' written instructions using concealed fasteners to greatest extent possible.

## 3.2 FIELD QUALITY CONTROL

A. Field Quality-Control Testing: Perform the following test on representative areas of aluminum-framed entrances and storefronts.

1. Water-Spray Test: Before installation of interior finishes has begun, areas designated by Architect shall be tested according to AAMA 501.2 and shall not evidence water penetration.

a. Perform a minimum of two tests in areas as directed by Architect.

2. Air Infiltration: ASTM E783 at 1.5 times the rate specified for laboratory testing in "Performance Requirements" Article but not more than 0.09 cfm/sq. ft. at a static-air-pressure differential of 1.57 lbf/sq. ft..

a. Perform a minimum of two tests in areas as directed by Architect.

3. Water Penetration: ASTM E1105 at a minimum uniform and cyclic static-air-pressure differential of 0.67 times the static-air-pressure differential specified for laboratory testing in "Performance Requirements" Article, but not less than 6.24 lbf/sq. ft., and shall not evidence water penetration.

B. Aluminum-framed entrances and storefronts will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

## 3.3 ENTRANCE DOOR HARDWARE SETS

END OF SECTION 084113

# SECTION 084229.23 - SLIDING AUTOMATIC ENTRANCES

## 1.1 SUMMARY

A. Sliding, exterior, power-operated entrances.

## 1.2 QUALITY ASSURANCE

A. Installer: Employs AAADM Certified Inspector.

## 1.3 WARRANTY

A. Materials and Workmanship: Two years.

B. Finish: Five years.

C. Glazing: 10 year guaranteed vacuum -seal.

## 1.4 PERFORMANCE REQUIREMENTS

A. Power-Operated Door Standard: BHMA A156.10.

B. Structural Performance: Contractor to design entrances.

C. Exterior windows and masonry openings shall be weather-tested using the Voluntary Specification for Field Testing of Windows and Sliding Doors (AAMA 502-02) test method B.

## 1.5 SLIDING AUTOMATIC ENTRANCES

A. Type: Sliding.

B. Configuration: Single-sliding door with one sliding leaf.

1. Traffic Pattern: One way.
2. Mounting: Between jambs.

C. Sliding-Door Threshold: No threshold across door opening and recessed guide-track system at sidelites.

D. Glazing: Glazing shall be clear glass panes, low-e treated, double glazed.

E. Controls:

1. Activation Device: Motion sensor.
2. Safety Device: Two photoelectric beams mounted in sidelite jambs on each side of door.

3. Sidelite Safety Device: Presence sensor, mounted above each sidelite on side of door opening through which doors travel, to detect obstructions.
4. Opening-Width Control: Switch to reduce opening to a selected partial opening width.

F. Finish: Class I, clear anodic Matching adjacent storefront.

1.6 ENTRANCE COMPONENTS

A. Framing Members: Extruded aluminum.

B. Stile and Rail Doors:

1. Stile Design: Medium.
2. Rail Design: 5-inch height.

C. Headers: Concealed; one side of header flush with framing.

D. Locking: Deadlocks.

1.7 FIELD QUALITY CONTROL

A. Inspection by Installer's AAADM Certified Inspector.

END OF SECTION 084229.23

# SECTION 085113 - ALUMINUM WINDOWS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section includes aluminum windows for exterior locations. Operable tilt-turn windows. Casement swings inward.

B. Glazing shall be clear glass panes, low-e treated, double glazed

### 1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include plans, elevations, sections, hardware, accessories, insect screens, operational clearances, and details of installation, including anchor, flashing, and sealant installation.

C. Samples: For each exposed product and for each color specified.

### 1.3 INFORMATIONAL SUBMITTALS

A. Product test reports.

B. Sample warranties.

### 1.4 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace aluminum windows that fail in materials or workmanship within specified warranty period.

1. Warranty Period:

a. Window: 2 years from date of Substantial Completion.
b. Aluminum Finish: 20 years from date of Substantial Completion.
c. Glazing: double glazed with a 10 year guaranteed vacuum -seal.

PART 2 - PRODUCTS

## 2.1 WINDOW PERFORMANCE REQUIREMENTS

A. Product Standard: Comply with AAMA/WDMA/CSA 101/I.S.2/A440 for definitions and minimum standards of performance, materials, components, accessories, and fabrication unless more stringent requirements are indicated.

1. Window Certification: AAMA certified with label attached to each window.

B. Performance Class and Grade: AAMA/WDMA/CSA 101/I.S.2/A440 as follows:

1. Minimum Performance Class and grade: DAW-AW50.

C. Thermal Transmittance: NFRC 100 maximum whole-window U-factor of 0.44 Btu/sq. ft. x h x deg F.

D. Solar Heat-Gain Coefficient (SHGC): NFRC 200 maximum whole-window SHGC of 0.44.

E. Condensation-Resistance Factor (CRF): Provide aluminum windows tested for thermal performance according to AAMA 1503, showing a CRF of 62 frame and 68 glass.

F. Thermal Movements: Provide aluminum windows, including anchorage, that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change: 120 deg F ambient; 180 deg F material surfaces.

G. Exterior windows and masonry openings shall be weather-tested using the Voluntary Specification for Field Testing of Windows and Sliding Doors (AAMA 502-02) test method B.

## 2.2 ALUMINUM WINDOWS

A. Kawneer Series NX-3700 Windows. Dual action window.

B. Operating Types: Tilt-turn/Dual Action. Casement swings inward.

C. Frames and Sashes: Aluminum extrusions complying with AAMA/WDMA/CSA 101/I.S.2/A440.

1. Thermally Broken Construction: Fabricate frames, sashes, and muntins with an integral, concealed, low-conductance thermal barrier located between exterior materials and window members exposed on interior side in a manner that eliminates direct metal-to-metal contact.

D. Insulating-Glass Units: ASTM E 2190.

1. Glass: ASTM C 1036, Type 1, Class 1, q3.

a. Tint: Clear.
b. Fully tempered.
c. Low-E.

2. Filling: Fill space between glass lites with argon.
3. Low-E Coating: Sputtered on second surface.
4. Glazing shall be clear glass panes, low-e treated, double glazed with a 10 year guaranteed vacuum -seal.

E. Glazing System: Manufacturer's standard factory-glazing system that produces weathertight seal.

F. Hardware, General: Provide manufacturer's standard corrosion-resistant hardware sized to accommodate sash weight and dimensions.

1. Exposed Hardware Color and Finish: As selected by Architect from manufacturer's full range.

G. Projected Window Hardware:

1. Gear-Type Rotary Operators: Complying with AAMA 901 when tested according to ASTM E 405, Method A. Provide operators that function without requiring the removal of interior screens or using screen wickets.

a. Type and Style: As selected by Architect from manufacturer's full range of types and styles.

2. Hinges: Non-friction type, not less than two per sash.
3. Lock: Manufacturer's standard.

H. Weather Stripping: Provide full-perimeter weather stripping for each operable sash unless otherwise indicated.

I. Fasteners: Noncorrosive and compatible with window members, trim, hardware, anchors, and other components.

1. Exposed Fasteners: Do not use exposed fasteners to greatest extent possible. For application of hardware, use fasteners that match finish hardware being fastened.

## 2.3 ACCESSORIES

A. Panning Trim: Extruded-aluminum profiles in sizes and configurations indicated on Drawings.

B. Receptor System: Two-piece, snap-together, thermally broken, extruded-aluminum receptor system that anchors windows in place.

## 2.4 INSECT SCREENS

A. General: Fabricate insect screens to integrate with window frame. Provide screen for each operable exterior sash. Screen wickets are not permitted.

1. Type and Location: Full, outside for project-in sashes.

B. Aluminum Frames: Complying with SMA 1004 or SMA 1201.

C. Glass-Fiber Mesh Fabric: 18-by-14 or 18-by-16 mesh of PVC-coated, glass-fiber threads; woven and fused to form a fabric mesh resistant to corrosion, shrinkage, stretch, impact damage, and weather deterioration. Comply with ASTM D 3656/D 3656M.

1. Mesh Color: Manufacturer's standard.

## 2.5 FABRICATION

A. Fabricate aluminum windows in sizes indicated. Include a complete system for assembling components and anchoring windows.

B. Glaze aluminum windows in the factory.

C. Weather strip each operable sash to provide weathertight installation.

D. Weep Holes: Provide weep holes and internal passages to conduct infiltrating water to exterior.

E. Provide water-shed members above side-hinged sashes and similar lines of natural water penetration.

F. Mullions: Provide mullions and cover plates, matching window units, complete with anchors for support to structure and installation of window units. Allow for erection tolerances and provide for movement of window units due to thermal expansion and building deflections. Provide mullions and cover plates capable of withstanding design wind loads of window units.

G. Complete fabrication, assembly, finishing, hardware application, and other work in the factory to greatest extent possible. Disassemble components only as necessary for shipment and installation.

## 2.6 ALUMINUM FINISHES

A. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

B. Class I, Clear Anodic Finish: AA-M12C22A41 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with manufacturer's written instructions for installing windows, hardware, accessories, and other components. For installation procedures and requirements not addressed in manufacturer's written instructions, comply with installation requirements in ASTM E 2112.

B. Install windows level, plumb, square, true to line, without distortion or impeding thermal movement, anchored securely in place to structural support, and in proper relation to wall flashing and other adjacent construction to produce weathertight construction.

C. Install windows and components to drain condensation, water penetrating joints, and moisture migrating within windows to the exterior.

D. Separate aluminum and other corrodible surfaces from sources of corrosion or electrolytic action at points of contact with other materials.

E. Adjust operating sashes and hardware for a tight fit at contact points and weather stripping for smooth operation and weathertight closure.

F. Clean exposed surfaces immediately after installing windows. Avoid damaging protective coatings and finishes. Remove excess sealants, glazing materials, dirt, and other substances.

G. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.

END OF SECTION 085113

# SECTION 086250 – TUBULAR DAYLIGHTING DEVICES

## PART 1 GENERAL

### SECTION INCLUDES

A. Tubular daylighting devices and accessories.

### RELATED SECTIONS

B. Section 07600 [07 60 00] – Flashing and Sheet Metal: Metal curb flashings.

C. Section 08620 [08 60 00] - Unit Skylights: Skylights without reflective tube.

D. Section 08630 [08 63 00] - Metal Framed Skylights.

### REFERENCES

E. ASTM B 209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

F. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

G. ASTM A 463/A 463M - Standard Specification for Steel Sheet, Aluminum Coated, by the Hot Dip Process.

H. ASTM A 653/A 653M - Standard Specification for Steel Sheet, Zinc Coated (Galvanized), by the Hot Dip Process.

I. ASTM A 792/A 792M – Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process.

J. ASTM E 108 - Standard Test Methods for Fire Tests of Roof Coverings.

K. ASTM E 283 - Test Method for Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.

L. ASTM E 308 - Standard Practice for Computing the Colors of Objects by Using the CIE System.

M. ASTM E 330 - Structural Performance of Exterior Windows, Curtain Walls and Doors.

N. ASTM E 547 - Test Method for Water Penetration of Exterior Windows, Skylights, Doors and Curtain walls by Cyclic Air Pressure Difference.

O. ASTM E 1886 - Standard Test Method for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Missile(s) and Exposed to Cyclic Pressure Differentials.

P. ASTM E 1996 - Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Windborne Debris in Hurricane.

Q. ASTM D 635 - Test Method for Rate of Burning and/or Extent of Time of Burning of Self-Supporting Plastics in a Horizontal Position.

R. ASTM D 1929 - Test Method for Ignition Properties of Plastics.

S. ASTM D 2843 – Standard Test Method for Density of Smoke from the Burning or Decomposition of Plastics.

T. ASTM F 1642 – Standard Test Method for Glazing and Glazing Systems Subject to Airblast Loading.

U. ASTM F 2912 – Standard Specification for Glazing and Glazing Systems Subject to Airblast Loading.

V. AAMA/WDMA/CSA 101/I.S.2/A440 - Standard/Specification for Windows, Doors, and Unit Skylights; 2011

W. FM Standard 4431 - The Approval Standard for Skylights

X. UL 2108 - Low Voltage Lighting Systems

Y. GSA-TS01-2003: Standard Test Method for Glazing and Window Systems Subject to Dynamic Overpressure Loadings

Z. Unified Facilities Criteria (UFC) 4-010-01, Change October 2013, DoD Minimum Antiterrorism Standards for Buildings,

AA. CSA C22.2 No. 250.0 – Luminaires.

BB. ICC-ES AC-16 - Acceptance Criteria for Plastic Skylights; 2008.

CC. Florida Building Code TAS 201 – Impact Test Procedures.

DD. Florida Building Code TAS 202 – Criteria for Testing Impact and Non Impact Resistant Building Envelope Components Using Uniform Static Air Pressure Loading.

EE. Florida Building Code TAS 203 – Criteria for Testing Products Subject to Cyclic Wind Pressure Loading

FF. IBC Section 1710 - Load Test Procedure for Wind Load Testing on Rooftop Daylight Collecting System - Structural Performance Testing - Devised by ATI PE); 2012

GG. IBC Section 2606.7.2 – Installation – Diffuser Fall Out Test (Devised by PE); 2012

HH. OSHA 29 CFR - 1910.23 (e)(8) (Guarding Requirements for Skylights); 1926 Subpart M (Fall Protection); 1926.501(b)(4)(i); 1926.501(i)(2); 1926.501(b)(4)(ii)

II. California State OSHA Fall Protection Code of Regulations, Title 8, Section 3212 (e)(1)

PERFORMANCE REQUIREMENTS

JJ. Daylight Reflective Tubes: Spectralight Infinity with Cool Tube Technology combines ultra-high Visible Light reflectance with Ultra-low Infrared (IR) reflectance. Patented spectrally-selective optical surface yields an average total- and specular-reflectance greater than 99.5% percent for the Visible Light spectrum (400 nm to 700 nm) providing maximized visible light transmission and less than 25% reflectance for Infrared (IR) heat wavelengths (750 nm to 2500 nm) for minimized heat transmission, resulting in a spectrally-selective Total Solar Spectrum (250 nm to 2500 nm) reflectance less than 37 percent, as measured using a Perkin Elmer Lambda 1050 spectrophotometer with a Universal Reflectance Accessory. Color: a* and b* (defined by CIE L*a*b* color model) shall not exceed plus 2 or be less than minus 2 as determined in accordance to ASTM E 308.

KK. SOLAMASTER 750 DS-O / 750 DS-C (OPEN/CLOSED CEILING)
1. AAMA/WDMA/CSA 101/IS2/A440, Class CW-PG70, size tested 21 inch (533 mm) diameter, Type TDDOC and Type TDDCC.
   a. Air Infiltration Test:
      1) Air infiltration will not exceed 0.30 cfm/sf aperture with a pressure delta of 1.57 psf across the tube when tested in accordance with ASTM E 283.
   b. Water Resistance Test:
      1) Passes water resistance; no uncontrolled water leakage with a pressure differential of 10.7 psf (512 Pa) or 15 percent of the design load (whichever is greater) and a water spray rate of 5 gallons/hour/sf for 24 minutes when tested in accordance with ASTM E 547 and ASTM E 331.
   c. Uniform Load Test: All units tested with a safety factor of (3) for positive pressure and (2) for negative pressure, acting normal to plane of roof in accordance with ASTM E 330.
      1) No breakage, permanent damage to fasteners, hardware parts, or damage to make daylighting system inoperable or cause excessive permanent deflection of any section when tested at a Positive Load of 150 psf (7.18 kPa) or Negative Load of 70 psf (3.35 kPa).
2. Hurricane Resistance:
   a. Meets Florida Building Code TAS, 201, TAS, 202 and TAS 203 for Impact and non-impact components for HVHZ and non-HVHZ applications.
   b. Meets ASTM E 1886 and ASTM E1996 for missile and cyclic pressure differential testing for TDI Windstorm zones.
3. Fire Testing:
   a. Fire Rated Roof Assemblies:
      1) When used with the Dome Edge Protection Band, all domes meet fire rating requirements as described in the International Building Code for Class A, B, and C roof assemblies.
   b. When used with the Dome Edge Protection Band, all domes meet fire rating requirements as described in the International Building Code.
   c. Self-Ignition Temperature - Greater than 650 degrees F per ASTM D-1929.
   d. Smoke Density: Rating no greater than 450 per ASTM Standard E 84 in way intended for use. Classification C.

e. Rate of Burn and/or Extent: Maximum Burning Rate: 2.5 inches/min (62 mm/min) Classification CC-2 per ASTM D 635.
f. Rate of Burn and/or Extent: Maximum Burn Extent: 1 inch (25 mm) Classification CC-1 per ASTM D 635.

4. FM Certification:
   a. Spread of Flame: Passes: Class A at 5 in12. No flame spread when tested in accordance with FM modified version of ASTM E108 Fire Test of Roof Coverings.
   b. Simulated Hail Resistance (Pre UV Exposure): Passes: No cracking or breaks when tested with nominal 2.0 in. (51 mm) diameter ice ball having a kinetic energy of 26.8 ft-lbs (36.4J)
   c. Simulated Hail Resistance (Post UV Exposure): Passes: No cracking or breaks when tested with nominal 2.0 in. (51 mm) diameter ice ball having a kinetic energy of 26.8 ft-lbs (36.4J) after no less than 1000 hours of ultraviolet (UV) light exposure.
   d. Simulated Impact: Passes: No breakage or through openings when a 100 lb (45.5 kg) weight dropped from 4 ft (1.2 m) above highest point of test sample.
   e. Simulated Wind Uplift: Passes: 195 psf Wind Rating. No separation, breaking or cracking occurred when tested in accordance with FM 4431.
5. Fall Protection Performance:
6. Passes fall protection test: No penetration of dome or curb cap when subject to 400 lb (160 Kg)/42 inch (1066 mm) impact drop test when tested in accordance with OSHA 29 CFR 1926.506(c) Safety Net Systems.
   a. Passes fall protection test: California State OSHA Fall Protection Code of Regulations, Title 8, Section 3212 (e)(1) Skylight Screens.
7. Blast Resistance: ASTM F1642, ASTM F2912, GSA-TS01-2003, and UFC 4-010-01:
   a. Airblast Loading ASTM Hazard Rating: Passes: No Hazard Rating
   b. Airblast Loading UFC Level of Protection: Passes Medium Level of Protection
   c. Dynamic Overpressure Loading ASTM Hazard Rating: Passes: No Hazard Rating
   d. Dynamic Overpressure Loading UFC Level of Protection: Passes Medium Level of Protection

SUBMITTALS

LL. Submit under provisions of Section 01 30 00.

MM. Product Data: Manufacturer's data sheets on each product to be used, including:
1. Preparation instructions and recommendations.
2. Storage and handling requirements and recommendations.
3. Data sheets showing roof dome assembly, flashing base, reflective tubes, diffuser assembly, and accessories.
4. Installation requirements.

NN. Shop Drawings. Submit shop drawings showing layout, profiles and product components, including rough opening and framing dimensions, anchorage, roof flashings and accessories.

OO. Electrical wiring diagrams and recommendations for power and control wiring.

PP. Verification Samples: As requested by Architect.

QQ. Test Reports: Independent testing agency or evaluation service reports verifying compliance with specified performance requirements.

RR. LEED Submittals: Provide documentation of how the requirements of Credit will be met:
1. List of Daylight Credits available for the products specified.
2. Data on Energy Optimization Performance Credits for the products specified.
3. Data on Perimeter and Non-Perimeter Controllability of Systems for use of Daylight Dimmer option with the products specified.
4. Data on potential Innovation in Design Credits which may be available for the innovative use of the products specified.

QUALITY ASSURANCE

SS. Manufacturer Qualifications: Engaged in manufacture of tubular daylighting devices for minimum 20 years.

DELIVERY, STORAGE, AND HANDLING

TT. Deliver products in manufacturer's original containers, dry, undamaged, seals and labels intact.

UU. Store products in manufacturer's unopened packaging until ready for installation.

PROJECT CONDITIONS

VV. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

WARRANTY

WW. Daylighting Device: Manufacturer's standard warranty for 10 years.

XX. Electrical Parts: Manufacturer's standard warranty for 5 years, unless otherwise indicated.

YY. LED Emitters, Drivers and Controls: Manufacturer’s standard warranty for 3 years against failure.

PART 2 PRODUCTS

MANUFACTURERS

A. Acceptable Manufacturer: Solatube International, Inc.; 2210 Oak Ridge Way, Vista, CA 92081. Tel. Toll Free: 888-765-2882. Tel: (760) 477-1120. Fax: (760) 597-4488. Email: commsales@solatube.com. Web: www.solatube.com. Distributor for Maryland – CBG South – ph (410) 995-6400 – www.cbgsouth.com .

TUBULAR DAYLIGHTING DEVICES

B. Tubular Daylighting Devices General: Transparent roof-mounted skylight dome and self-flashing curb, reflective tube, and ceiling level diffuser assembly, transferring sunlight to interior spaces; complying with ICC AC-16.

C. SolaMaster Series: Solatube Model 750 DS, 21 inch (530 mm) Daylighting System:
   1. Model:
      a. Solatube Model 750 DS-C Closed (Penetrating) Ceiling. AAMA Type TDDCC.
   2. Capture Zone:
      a. Roof Dome Assembly: Transparent, UV and impact resistant dome with flashing base supporting dome and top of tube.
         1) Outer Dome Glazing: Type DA, 0.125 inch (3.2 mm) minimum thickness injection molded acrylic classified as CC2 material; UV inhibiting (100 percent UV C, 100 percent UV B and 98.5 percent UV A), impact modified acrylic blend.
            (a) Raybender 3000: Variable prism optic molded into outer dome to capture low angle sunlight and limit high angle sunlight.
         2) Inner Dome Glazing: Type DAI, 0.115 inch (3 mm) minimum thickness acrylic classified as CC2 material.
      b. Tube Ring: 0.090 inch (2.3 mm) nominal thickness injection molded high impact PVC. Prevents thermal bridging between base flashing and tubing and channel condensed moisture. Attached to base of dome ring with butyl glazing rope 0.24 inch (6 mm) diameter; to minimize air infiltration.
      c. Dome Seal: Adhesive backed weatherstrip, 0.63 inch (16 mm) tall by 0.28 inch (7 mm) wide.
   3. Dome Options:
      a. Security Bar: Type B Security Bar 0.375 inch (95 mm) stainless steel bar across flashing diameter opening.
      b. Dome Edge Protection Band for Curb Cap: Type PBC, for fire rated Class A, B or C roof applications with 750 DS Domes on Curb Cap Flashing installations. Galvanized steel. Nominal thickness of 0.039 inch (1 mm). For use with Curb Cap Flashing (Type FC), only.
   4. Flashings:
      a. Roof Flashing Base:
         1) One Piece: One piece, seamless, leak-proof flashing functioning as base support for dome and top of tube. Sheet steel, corrosion resistant conforming to ASTM A 653/A 653M or ASTM A 463/A 463M or ASTM A792/A 792M, 0.028 inch (0.7 mm) plus or minus .006 inch (.015 mm) thick.
            (a) Base Style: Type FC, Curb cap, with inside dimensions of 27 inches by 27 inches (685 mm by 685 mm) to cover curb as specified in Section 07600.
      b. Flashing Options:
         1) Curb Insulator: Curb Insulator, Type CI, Thermal isolation material is for use under flashing Type FC.
         2) Curb Cap Insulation: Type CCI, Nominal 1 inch thick thermal insulation pad to reduce thermal conduction between curb-cap and tubing and thermal convection between room air and curb-cap. Rated R-6 ($^{O}$Fxft2xhr/Btu) Insulation is Polyisocyanurate foam utilizing CFC,

HCFC, & HFC free blowing agent. Type-1 Class-1 per ASTM C 1289; Passes UL 1715 (15-minute thermal barrier per IBC 2603.4); Attic ventilation may be required per IBC 1203.2(OFxft$^2$xhr/Btu)

5. Transfer Zone:
   a. Extension Tubes: Aluminum sheet, thickness 0.018 inch (0.5 mm) conforming to ASTM B 209.
      1) Reflective Tubes:
         (a) Reflective extension tube, Type EXX and Type EL with total length of run as indicated on the Drawings.
         (b) Interior Finish: Spectralight Infinity with Cool Tube Technology combining ultra-high Visible Light reflectance with Ultra-low Infrared (IR) reflectance.
      2) Tube Options
         (a) Top Tube Angle Adapter and Bottom Tube Angle Adapter Kit: Type AK, Reflective 45 degree adjustable top and bottom angle adapters (one each), 16 inches (406 mm) long
         (b) Spectralight Infinity SoftLight Extension Tube: Type ES, 24 inch (610 mm) Super-reflective extension tube with structured surface providing precise light spread for enhanced visual comfort. Replaces one standard 24 inch (610 mm) extension tube in the tube assembly.
         (c) Thermal Insulation Panel: Type TIP, high-performance dual-glazed, thermally-broken tube insulation system.
         (d) Wire Suspension Kit: Type E, Use the wire suspension kit when additional bracing to the structure is required.
6. Delivery Zone:
   a. Diffuser Assemblies for Tubes Penetrating Ceilings: Solatube Model 750 DS-C. Ceiling mounted box transitioning from round tube to square ceiling assembly, supporting light transmitting surface at bottom termination of tube; 23.8 inches by 23.8 inches (605 mm by 605 mm) square frame to fit standard suspended ceiling grids or hard ceilings.
      1) Metal Transition Box: Type TM, Metal Round to Square transition box comprised of Spectralight Infinity SoftLight material with structured finish on exposed reflective surface, .015 in (0.4 mm) thick. Color: a* and b* (defined by CIE L*a*b* color model) shall not exceed plus 2 or be less than minus 2 as determined in accordance to ASTM E 308.
      2) Lens: Type L1, OptiView Fresnel lens design to maximize light output and diffusion with extruded aluminum frame and EPDM foam seal to minimize condensation and bug, dirt and air infiltration per ASTM E 283. Visible Light Transmission shall be greater than 90 percent at 0.022 inch (0.6 mm) thick. Classified as CC2.
      3) Supplemental Natural Effect Lens Type LN, Lens made of acrylic, classified as CC2, Class C, 0.060 inch (1.5 mm) thick, with open cell foam seal to minimize condensation and bug, dirt and air infiltration per ASTM E 283.

ACCESSORIES

D. Fasteners: Same material as metals being fastened, non-magnetic steel, non-corrosive metal of type recommended by manufacturer, or injection molded nylon.

E. Suspension Wire: Steel, annealed, galvanized finish, size and type for application and ceiling system requirement.

F. Sealant: Polyurethane or copolymer based elastomeric sealant as provided or recommended by manufacturer.

## PART 3 EXECUTION

### EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. Examine openings, substrates, structural support, anchorage, and conditions for compliance with requirements for installation tolerances and other conditions.

C. If substrate and rough opening preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

### PREPARATION

D. Clean surfaces thoroughly prior to installation.

E. Coordinate requirements for power supply, conduit and wiring.

F. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

### INSTALLATION

G. Install in accordance with manufacturer's printed instructions.
H. Installer must wear sunglasses.

I. Coordinate installation with substrates, air and vapor retarders, roof insulation, roofing membrane, and flashing to ensure that each element of the Work performs properly and that finished installation is weather tight.
   1. Install flashing to produce weatherproof seal with curb and overlap with roofing system termination at top of curb.
   2. Provide thermal isolation when components penetrate or disrupt building insulation. Pack fibrous insulation in rough opening to maintain continuity of thermal barriers.
   3. Coordinate attachment and seal of perimeter air and vapor barrier material.

J. Where metal surfaces of tubular unit skylights will contact incompatible metal or corrosive substrates, including preservative-treated wood, provide permanent separation as recommended by manufacturer

K. Align device free of warp or twist, maintain dimensional tolerances.

L. After installation of first unit, field test to determine adequacy of installation. Conduct water test in presence of Owner, Architect, or Contractor, or their designated representative. Correct if needed before proceeding with installation of subsequent units.

M. Inspect installation to verify secure and proper mounting. Test each fixture to verify operation, control functions, and performance. Correct deficiencies.

CLEANING

N. Clean exposed surfaces according to manufacturer's written instructions. Touch up damaged metal coatings and finishes. Remove excess sealants, glazing materials, dirt, and other substances.

PROTECTION

O. Protect installed products until completion of project.

P. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION

# SECTION 087100 - DOOR HARDWARE

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Mechanical door hardware for the following:

a. Swinging doors.

2. Cylinders for door hardware specified in other Sections.

### 1.2 PREINSTALLATION MEETINGS

A. Keying Conference: Conduct conference at Project site.

### 1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each exposed product in each finish specified.

C. Door hardware schedule.

D. Keying schedule.

### 1.4 INFORMATIONAL SUBMITTALS

A. Sample warranty.

### 1.5 CLOSEOUT SUBMITTALS

A. Maintenance data.

### 1.6 QUALITY ASSURANCE

A. Installer Qualifications: Supplier of products and an employer of workers trained and approved by product manufacturers and of an Architectural Hardware Consultant who is available during the course of the Work to consult Contractor, Architect, and Owner about door hardware and keying.

1. Scheduling Responsibility: Preparation of door hardware and keying schedule.

2. Engineering Responsibility: Preparation of data for electrified door hardware, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.

B. Architectural Hardware Consultant Qualifications: A person who is experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project and who is currently certified by DHI as an Architectural Hardware Consultant (AHC).

## 1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Three years from date of Substantial Completion unless otherwise indicated below:
   a. Exit Devices: Two years from date of Substantial Completion.
   b. Manual Closers: 10 years from date of Substantial Completion.

# PART 2 - PRODUCTS

## 2.1 PERFORMANCE REQUIREMENTS

A. Fire-Rated Door Assemblies: Where fire-rated doors are indicated, provide door hardware complying with NFPA 80 that is listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.

B. Means of Egress Doors: Latches do not require more than 15 lbf to release the latch. Locks do not require use of a key, tool, or special knowledge for operation.

C. Accessibility Requirements: For door hardware on doors in an accessible route, comply with the DOJ's "2010 ADA Standards for Accessible Design".

## 2.2 SCHEDULED DOOR HARDWARE

A. Provide products for each door that comply with requirements indicated in Part 2 and door hardware schedule.

1. Door hardware is scheduled on Drawings.

## 2.3 HINGES

A. Hinges: BHMA A156.1. Provide template-produced hinges for hinges installed on hollow-metal doors and hollow-metal frames.

B. Exterior Door Hinges: Roton type door hinges.

## 2.4 MECHANICAL LOCKS AND LATCHES

A. Lock Functions: As indicated in door hardware schedule.

B. Mortise Lock Sets: Yale 8800 FL Series, AVR trim design and 2196-6 cylinder.

C. Cylinder Lock Sets: Yale 5400 LN Series, AU trim design and 1210 core.

D. Lock Throw: Comply with testing requirements for length of bolts required for labeled fire doors, and as follows:
   1. Mortise Locks: Minimum 3/4-inch latchbolt throw.

E. Lock Backset: 2-3/4 inches unless otherwise indicated.

F. Lock Trim:
   1. Levers: Forged.

G. Strikes: Provide manufacturer's standard strike for each lock bolt or latchbolt complying with requirements indicated for applicable lock or latch and with strike box and curved lip extended to protect frame; finished to match lock or latch.

   1. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.
   2. Extra-Long-Lip Strikes: For locks used on frames with applied wood casing trim.
   3. Aluminum-Frame Strike Box: Manufacturer's special strike box fabricated for aluminum framing.
   4. Rabbet Front and Strike: Provide on locksets for rabbeted meeting stiles.

## 2.5 AUXILIARY LOCKS

A. Mortise Auxiliary Locks: BHMA A156.36; Grade 1; with strike that suits frame.

B. Narrow Stile Auxiliary Locks: BHMA A156.36; Grade 1; with strike that suits frame.

## 2.6 MANUAL FLUSH BOLTS

A. Manual Flush Bolts: BHMA A156.16; minimum 3/4-inch throw; designed for mortising into door edge.

## 2.7 EXIT DEVICES AND AUXILIARY ITEMS

A. Exit Devices and Auxiliary Items: BHMA A156.3.

## 2.8 LOCK CYLINDERS

A. Lock Cylinders: Tumbler type, constructed from brass or bronze, stainless steel, or nickel silver. Provide cylinder from same manufacturer of locking devices.

B. Standard Lock Cylinders: BHMA A156.5; Grade 1 permanent cores; face finished to match lockset.

1. Core Type: Interchangeable.

C. Cylinders and Keying: Cylinders shall be keyed to an existing grand master key system. Provide Yale original 6 pin cylinders and keys. Furnish construction cylinders and keying for use during the construction period. Permanent cores shall be installed by UM upon completion of the project.

## 2.9 OPERATING TRIM

A. Operating Trim: BHMA A156.6; aluminum unless otherwise indicated.

## 2.10 ACCESSORIES FOR PAIRS OF DOORS

A. Astragals: BHMA A156.22.

## 2.11 SURFACE CLOSERS

A. Surface Closers: BHMA A156.4; rack-and-pinion hydraulic type with adjustable sweep and latch speeds controlled by key-operated valves and forged-steel main arm. Comply with manufacturer's written instructions for size of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Provide factory-sized closers, adjustable to meet field conditions and requirements for opening force.

## 2.12 MECHANICAL STOPS AND HOLDERS

A. Wall- and Floor-Mounted Stops: BHMA A156.16.

## 2.13 DOOR GASKETING

A. Door Gasketing: BHMA A156.22; with resilient or flexible seal strips that are easily replaceable and readily available from stocks maintained by manufacturer.

B. Maximum Air Leakage: When tested according to ASTM E 283 with tested pressure differential of 0.3-inch wg, as follows:
1. Gasketing on Single Doors: 0.3 cfm/sq. ft. of door opening.
2. Gasketing on Double Doors: 0.50 cfm per foot of door opening.

## 2.14 THRESHOLDS

A. Thresholds: BHMA A156.21; fabricated to full width of opening indicated.

2.15 FINISHES

A. Provide finishes complying with BHMA A156.18 as indicated in door hardware schedule.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Mounting Heights: Mount door hardware units at heights to comply with the following unless otherwise indicated or required to comply with governing regulations.

1. Standard Steel Doors and Frames: ANSI/SDI A250.8.
2. Custom Steel Doors and Frames: HMMA 831.

B. Install each door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work. Do not install surface-mounted items until finishes have been completed on substrates involved.

C. Hinges: Install types and in quantities indicated in door hardware schedule, but not fewer than the number recommended by manufacturer for application indicated or one hinge for every 30 inches of door height, whichever is more stringent, unless other equivalent means of support for door, such as spring hinges or pivots, are provided.

D. Lock Cylinders: Install construction cores to secure building and areas during construction period.

1. Replace construction cores with permanent cores as indicated in keying schedule.
2. Furnish permanent cores to Owner for installation.

E. Thresholds: Set thresholds for exterior doors and other doors indicated in full bed of sealant complying with requirements specified in Section 079200 "Joint Sealants."

F. Stops: Provide floor stops for doors unless wall or other type stops are indicated in door hardware schedule. Do not mount floor stops where they will impede traffic.

G. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.

1. Do not notch perimeter gasketing to install other surface-applied hardware.

H. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.

I. Door Bottoms: Apply to bottom of door, forming seal with threshold when door is closed.

3.2 ADJUSTING

A. Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended.

Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

3.3 DOOR HARDWARE SCHEDULE

END OF SECTION 087100

# SECTION 092216 - NON-STRUCTURAL METAL FRAMING

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:

1. Non-load-bearing steel framing systems for interior gypsum board assemblies.
2. Suspension systems for interior gypsum ceilings, soffits, and grid systems.

### 1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics: For fire-resistance-rated assemblies that incorporate non-load-bearing steel framing, provide materials and construction identical to those tested in assembly indicated, according to ASTM E 119 by an independent testing agency.

### 2.2 FRAMING SYSTEMS

A. Framing Members, General: Comply with ASTM C 754 for conditions indicated.

1. Steel Sheet Components: Comply with ASTM C 645 requirements for metal unless otherwise indicated.
2. Protective Coating: ASTM A 653/A 653M, G40, hot-dip galvanized unless otherwise indicated.

B. Studs and Runners: ASTM C 645**.**

1. Steel Studs and Runners:

    a. Minimum Base-Metal Thickness: 0.018 inch.
    b. Depth: As indicated on Drawings.

C. Slip-Type Head Joints: Where indicated, provide the following:

1. Deflection Track: Steel sheet top runner manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.

    a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

        1) ClarkDietrich Building Systems; SLP-TRK Slotted Deflection Track.
        2) MBA Building Supplies; FlatSteel Deflection Track.
        3) Steel Network Inc. (The); VertiClip SLD Series.
        4) Telling Industries; Vertical Slip Track.

D. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.

1. Minimum Base-Metal Thickness: 0.027 inch.

E. Hat-Shaped, Rigid Furring Channels: ASTM C 645.

1. Minimum Base-Metal Thickness: 0.018 inch.
2. Depth: As indicated on Drawings.

F. Resilient Furring Channels: 1/2-inch deep, steel sheet members designed to reduce sound transmission.

1. Configuration: Asymmetrical or hat shaped.

G. Cold-Rolled Furring Channels: 0.053-inch uncoated-steel thickness, with minimum 1/2-inch- wide flanges.

1. Depth: As indicated on Drawings.
2. Furring Brackets: Adjustable, corrugated-edge type of steel sheet with minimum uncoated-steel thickness of 0.033 inch.
3. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch diameter wire, or double strand of 0.048-inch diameter wire.

H. Z-Shaped Furring: With slotted or nonslotted web, face flange of 1-1/4 inches, wall attachment flange of 7/8 inch, minimum uncoated-metal thickness of 0.018 inch, and depth required to fit insulation thickness indicated.

## 2.3 SUSPENSION SYSTEMS

A. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch diameter wire, or double strand of 0.048-inch diameter wire.

B. Hanger Attachments to Concrete:

1. Anchors: Fabricated from corrosion-resistant materials with holes or loops for attaching wire hangers and capable of sustaining, without failure, a load equal to 5 times that imposed by construction as determined by testing according to ASTM E 488 by an independent testing agency.

2. Powder-Actuated Fasteners: Suitable for application indicated, fabricated from corrosion-resistant materials with clips or other devices for attaching hangers of type indicated, and capable of sustaining, without failure, a load equal to 10 times that imposed by construction as determined by testing according to ASTM E 1190 by an independent testing agency.

C. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.16 inch in diameter.

D. Flat Hangers: Steel sheet, 1 by 3/16 inch by length indicated.

E. Carrying Channels: Cold-rolled, commercial-steel sheet with a base-metal thickness of 0.053 inch and minimum 1/2-inch wide flanges.

1. Depth: As indicated on Drawings.

F. Furring Channels (Furring Members):

1. Cold-Rolled Channels: 0.053-inch uncoated-steel thickness, with minimum 1/2-inch wide flanges, 3/4 inch deep.
2. Steel Studs and Runners: ASTM C 645.

a. Minimum Base-Metal Thickness: 0.018 inch.
b. Depth: As indicated on Drawings.

3. Hat-Shaped, Rigid Furring Channels: ASTM C 645, 7/8 inch deep.

a. Minimum Base-Metal Thickness: 0.018 inch.

4. Resilient Furring Channels: 1/2-inch deep members designed to reduce sound transmission.

G. Grid Suspension System for Gypsum Board Ceilings: ASTM C 645, direct-hung system composed of main beams and cross-furring members that interlock.

1. Basis of Design Product: Subject to compliance with requirements, provide USG Corporation; Drywall Suspension System, or comparable product by one of the following:

a. Armstrong World Industries, Inc.; Drywall Grid Systems.
b. Chicago Metallic Corporation; Drywall Grid System.

## 2.4 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards.

1. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

# PART 3 - EXECUTION

## 3.1 EXAMINATION

A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.2 PREPARATION

A. Suspended Assemblies: Coordinate installation of suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive hangers at spacing required to support the Work and that hangers will develop their full strength.

1. Furnish concrete inserts and other devices indicated to other trades for installation in advance of time needed for coordination and construction.

## 3.3 INSTALLATION, GENERAL

A. Installation Standard: ASTM C 754.

1. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.

B. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.

C. Install bracing at terminations in assemblies.

D. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

## 3.4 INSTALLING FRAMED ASSEMBLIES

A. Install framing system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.

B. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.

C. Install studs so flanges within framing system point in same direction.

D. Install tracks (runners) at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts penetrating partitions above ceiling.

1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.

    a. Install two studs at each jamb unless otherwise indicated.
    b. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch clearance from jamb stud to allow for installation of control joint in finished assembly.
    c. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.

3. Other Framed Openings: Frame openings other than door openings the same as required for door openings unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.

E. Z-Furring Members:

1. Erect insulation, specified in Section 072100 "Thermal Insulation," vertically and hold in place with Z-furring members spaced 24 inches o.c.
2. Except at exterior corners, securely attach narrow flanges of furring members to wall with concrete stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.
3. At exterior corners, attach wide flange of furring members to wall with short flange extending beyond corner; on adjacent wall surface, screw-attach short flange of furring channel to web of attached channel. At interior corners, space second member no more than 12 inches from corner and cut insulation to fit.

F. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.

## 3.5 INSTALLING SUSPENSION SYSTEMS

A. Install suspension system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.

1. Hangers: 48 inches o.c.
2. Carrying Channels (Main Runners): 48 inches o.c.
3. Furring Channels (Furring Members): 16 inches o.c unless indicated otherwise.

B. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.

C. Suspend hangers from building structure as follows:

1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.

    a. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.

2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.

    a. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced installation standards.

3. Wire Hangers: Secure by looping and wire tying, either directly to structures or to inserts, eye screws, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause hangers to deteriorate or otherwise fail.
4. Flat Hangers: Secure to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices and fasteners that are secure and appropriate for structure and hanger, and in a manner that will not cause hangers to deteriorate or otherwise fail.

D. Grid Suspension Systems: Attach perimeter wall track or angle where grid suspension systems meet vertical surfaces. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.

E. Installation Tolerances: Install suspension systems that are level to within 1/8 inch in 12 feet measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

END OF SECTION 092216

# SECTION 092900 - GYPSUM BOARD ASSEMBLIES

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:

1. Interior gypsum board.
2. Interior framing systems (e.g., supports for partition walls, framed soffits, furring, etc.).
3. Interior suspension systems (e.g., supports for ceilings, suspended soffits, etc.).

### 1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples: For the following products:

1. Trim Accessories: 12-inch long samples of each trim accessory indicated.

### 1.4 QUALITY ASSURANCE

A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.

### 1.5 STORAGE AND HANDLING

A. Store materials inside under cover and keep them dry and protected against damage from weather, condensation, direct sunlight, construction traffic, and other causes. Stack panels flat to prevent sagging.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent.

B. Do not install interior products until installation areas are enclosed and conditioned.

C. Do not install panels that are wet, those that are moisture damaged, and those that are mold damaged.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

**PART 2 - PRODUCTS**

2.1 PANELS, GENERAL

A. Size: Provide in maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

2.2 INTERIOR GYPSUM BOARD

A. General: Complying with ASTM C 1396/C 1396M, as applicable to type of gypsum board indicated and whichever is more stringent.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. G-P Gypsum.
b. Lafarge North America Inc.
c. National Gypsum Company.
d. USG Corporation.
e. CertainTeed Corp.

B. Regular Type:

1. Thickness: As indicated
2. Long Edges: Tapered.

C. Type X:

1. Thickness: As indicated
2. Long Edges: Tapered.

D. Ceiling Type: Manufactured to have more sag resistance than regular-type gypsum board.

1. Thickness: 1/2 inch.
2. Long Edges: Tapered.

E. Moisture and Mold-Resistant Type: With moisture- and mold-resistant core and surfaces.

1. Core: 5/8 inch, Type X.
2. Long Edges: Tapered.

## 2.3 NON-LOAD-BEARING STEEL FRAMING, GENERAL

A. Framing Members, General: Comply with ASTM C 754 for conditions indicated.

1. Steel Sheet Components: Comply with ASTM C 645 requirements for metal, unless otherwise indicated.
2. Protective Coating: Coating with equivalent corrosion resistance of ASTM A 653/A 653M, G40, hot-dip galvanized, unless otherwise indicated.

## 2.4 SUSPENSION SYSTEM COMPONENTS

A. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.0625-inch diameter wire, or double strand of 0.0475-inch diameter wire.

B. Hanger Attachments to Concrete:

1. Anchors: Fabricated from corrosion-resistant materials with holes or loops for attaching wire hangers and capable of sustaining, without failure, a load equal to 5] times that imposed by construction as determined by testing according to ASTM E 488 by an independent testing agency.

a. Type: As recommended by Manufacturer.

2. Powder-Actuated Fasteners: Suitable for application indicated, fabricated from corrosion-resistant materials with clips or other devices for attaching hangers of type indicated, and capable of sustaining, without failure, a load equal to 10 times that imposed by construction as determined by testing according to ASTM E 1190 by an independent testing agency.

C. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.162-inch diameter.

D. Flat Hangers: Steel sheet, in size indicated on Drawings.

E. Carrying Channels: Cold-rolled, commercial-steel sheet with a base-metal thickness of 0.0538 inch and minimum 1/2-inch- wide flanges.

1. Depth: As indicated on Drawings.

F. Furring Channels (Furring Members):

1. Cold-Rolled Channels: 0.0538-inch bare-steel thickness, with minimum 1/2-inch-wide flanges, 3/4 inch deep.
2. Steel Studs: ASTM C 645.

a. Depth: 20 gauge (0.036 inch).

3. Hat-Shaped, Rigid Furring Channels: ASTM C 645, 7/8 inch deep.

a. Minimum Base Metal Thickness: 0.0179 inch

4. Resilient Furring Channels: 1/2-inch- deep members designed to reduce sound transmission.

a. Configuration: Asymmetrical or hat shaped.

G. Grid Suspension System for Ceilings: ASTM C 645, direct-hung system composed of main beams and cross-furring members that interlock.

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

a. Armstrong World Industries, Inc.; Drywall Grid Systems.
b. Chicago Metallic Corporation; Drywall Furring System.
c. USG Corporation; Drywall Suspension System.

## 2.5 STEEL FRAMING FOR FRAMED ASSEMBLIES

A. Steel Studs and Runners: ASTM C 645.

1. Minimum Base-Metal Thickness: Min. 18 gauge unless indicated otherwise on drawings.
2. Depth: As indicated on Drawings.

B. Slip-Type Head Joints: Provide one of the following:

1. Double-Runner System: ASTM C 645 top runners, inside runner with 2-inch-deep flanges in thickness not less than indicated for studs and fastened to studs, and outer runner sized to friction fit inside runner.
2. Deflection Track: Steel sheet top runner manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.

    a. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

        1) Steel Network Inc. (The); VertiClip SLD or VertiTrack VTD Series.
        2) Superior Metal Trim; Superior Flex Track System (SFT).

    b. Locations: All full height partitions extending to floor or roof deck.

C. Firestop Tracks: Top runner manufactured to allow partition heads to expand and contract with movement of the structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

    a. Fire Trak Corp.; Fire Trak attached to studs with Fire Trak Slip Clip.
    b. Metal-Lite, Inc.; The System.

D. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.

1. Minimum Base-Metal Thickness: 16 Gauge (0.0598 inch).

E. Cold-Rolled Channel Bridging: 0.0538-inch bare-steel thickness, with minimum 1/2-inch- wide flanges.

1. Depth: As indicated on Drawings.
2. Clip Angle: Not less than 1-1/2 by 1-1/2 inches, 0.068-inch- thick, galvanized steel.

F. Hat-Shaped, Rigid Furring Channels: ASTM C 645.

1. Minimum Base Metal Thickness: As indicated on Drawings.
2. Depth: As indicated on Drawings.

G. Resilient Furring Channels: 1/2-inch- deep, steel sheet members designed to reduce sound transmission.

1. Configuration: Asymmetrical or hat shaped.

H. Cold-Rolled Furring Channels: 0.0538-inch bare-steel thickness, with minimum 1/2-inch- wide flanges.

1. Depth: As indicated on Drawings.
2. Furring Brackets: Adjustable, corrugated-edge type of steel sheet with minimum bare-steel thickness of 0.0312 inch.
3. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.0625-inch-diameter wire, or double strand of 0.0475-inch- diameter wire.

I. Z-Shaped Furring: With slotted or nonslotted web, face flange of 1-1/4 inches, wall attachment flange of 7/8 inch, minimum bare-metal thickness of 0.0179 inch, and depth required to fit insulation thickness indicated.

## 2.6 TRIM ACCESSORIES

A. Interior Trim: ASTM C 1047.

1. Material: Galvanized or aluminum-coated steel sheet, rolled zinc, plastic, or paper-faced galvanized steel sheet.
2. Shapes:

a. Cornerbead.

B. Aluminum Trim: Extruded accessories of profiles, dimensions, and locations as indicated on Drawings.

1. Manufacturers: Basis of Design shall be Softforms, SWR Series by Pittcon Softforms, LLC, or comparable products by one of the following:

a. Fry Reglet Corp.

2. Aluminum: Alloy and temper with not less than the strength and durability properties of ASTM B 221, Alloy 6063-T5.
3. Finish: Corrosion-resistant primer compatible with joint compound and finish materials specified.

## 2.7 JOINT TREATMENT MATERIALS

A. General: Comply with ASTM C 475/C 475M.

B. Joint Tape:

1. Interior Gypsum Wallboard: Paper.

2. Tile Backing Panels: As recommended by panel manufacturer.

C. Joint Compound for Interior Gypsum Wallboard: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.

1. Prefilling: At open joints, rounded or beveled panel edges, and damaged surface areas, use setting-type taping compound.
2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use drying-type, all-purpose compound.

a. Use setting-type compound for installing paper-faced metal trim accessories.

3. Fill Coat: For second coat, use drying-type, all-purpose compound.
4. Finish Coat: For third coat, use drying-type, all-purpose compound.

## 2.8 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.

B. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.

C. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.

1. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.

D. Isolation Strip at Exterior Walls: Provide one of the following:

1. Asphalt-Saturated Organic Felt: ASTM D 226, Type I (No. 15 asphalt felt), nonperforated.
2. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8 inch thick, in width to suit steel stud size.

# PART 3 - EXECUTION

## 3.1 EXAMINATION

A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames and framing, for compliance with requirements and other conditions affecting performance.

B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.2 APPLYING AND FINISHING PANELS, GENERAL

A. Comply with ASTM C 840.

B. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.

C. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch of open space between panels. Do not force into place.

D. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.

E. Form control and expansion joints with space between edges of adjoining gypsum panels.

F. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.

1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. in area.
2. Fit gypsum panels around ducts, pipes, and conduits.
3. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow 1/4- to 3/8-inch- wide joints to install sealant.

G. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments, except floors. Provide 1/4- to 1/2-inch- wide spaces at these locations, and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.

H. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.

## 3.3 APPLYING INTERIOR GYPSUM BOARD

A. Single-Layer Application:

1. On ceilings, apply gypsum panels before wall/partition board application to greatest extent possible and at right angles to framing, unless otherwise indicated.
2. On partitions/walls, apply gypsum panels vertically (parallel to framing), unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.

    a. Stagger abutting end joints not less than one framing member in alternate courses of panels.
    b. At stairwells and other high walls, install panels horizontally, unless otherwise indicated or required by fire-resistance-rated assembly.

3. On Z-furring members, apply gypsum panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.
4. Fastening Methods: Apply gypsum panels to supports with steel drill screws.

B. Multilayer Application:

1. On ceilings, apply gypsum board indicated for base layers before applying base layers on walls/partitions; apply face layers in same sequence. Apply base layers at right angles to framing members and offset face-layer joints 1 framing member, 16 inches minimum, from parallel base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly.
2. On partitions/walls, apply gypsum board indicated for base layers and face layers vertically (parallel to framing) with joints of base layers located over stud or furring member and face-layer joints offset at least one stud or furring member with base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.
3. On Z-furring members, apply base layer vertically (parallel to framing) and face layer either vertically (parallel to framing) or horizontally (perpendicular to framing) with vertical joints offset at least one furring member. Locate edge joints of base layer over furring members.
4. Fastening Methods: Fasten base layers with screws; fasten face layers with adhesive and supplementary fasteners.

C. Laminating to Substrate: Where gypsum panels are indicated as directly adhered to a substrate (other than studs, joists, furring members, or base layer of gypsum board), comply with gypsum board manufacturer's written recommendations and temporarily brace or fasten gypsum panels until fastening adhesive has set.

## 3.4 METAL FRAMING INSTALLATION, GENERAL

A. Installation Standard: ASTM C 754, except comply with framing sizes and spacing indicated.

1. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.

B. Install supplementary framing, and blocking to support surface-mounted fixtures, equipment services, heavy trim, grab bars, toilet accessories, shelves, furnishings, door stops, and similar construction.

C. Install bracing at terminations in assemblies.

D. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

## 3.5 INSTALLING SUSPENSION SYSTEMS

A. Install suspension system components in sizes and spacings indicated on Drawings, but not less than those required by referenced installation standards for assembly types and other assembly components indicated.

B. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.

C. Suspend hangers from building structure as follows:

1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.

a. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.

2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.

a. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced installation standards.

3. Wire Hangers: Secure by looping and wire tying, either directly to structures or to inserts, eye screws, or other devices and fasteners that are secure and

appropriate for substrate, and in a manner that will not cause hangers to deteriorate or otherwise fail.

4. Flat Hangers: Secure to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices and fasteners that are secure and appropriate for structure and hanger, and in a manner that will not cause hangers to deteriorate or otherwise fail.
5. Do not attach hangers to steel roof deck.
6. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
7. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.
8. Do not connect or suspend steel framing from ducts, pipes, or conduit.

D. Fire-Resistance-Rated Assemblies: Wire tie furring channels to supports.

E. Seismic Bracing: Sway-brace suspension systems with hangers used for support.

F. Grid Suspension Systems: Attach perimeter wall track or angle where grid suspension systems meet vertical surfaces. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.

G. Installation Tolerances: Install suspension systems that are level to within 1/8 inch in 12 feet measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

## 3.6 INSTALLING FRAMED ASSEMBLIES

A. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.

B. Install studs so flanges within framing system point in same direction.

1. Space studs as follows:

a. Single-Layer Application: As indicated on Drawings.
b. Multilayer Application: As indicated on Drawings.
c. Tile backing panels: As indicated on Drawings.

C. Install tracks (runners) at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings, except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts penetrating partitions above ceiling.

1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.

2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.

    a. Install two studs at each jamb, unless otherwise indicated.
    b. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch clearance from jamb stud to allow for installation of control joint in finished assembly.
    c. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.

3. Other Framed Openings: Frame openings other than door openings the same as required for door openings, unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.
4. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated and support closures and to make partitions continuous from floor to underside of solid structure.

    a. Firestop Track: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.

5. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.

D. Direct Furring:

1. Screw to wood framing.
2. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.

E. Z-Furring Members:

1. Erect insulation (specified in Division 07 Section "Thermal Insulation") vertically and hold in place with Z-furring members spaced 24 inches o.c.
2. Except at exterior corners, securely attach narrow flanges of furring members to wall with concrete stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.
3. At exterior corners, attach wide flange of furring members to wall with short flange extending beyond corner; on adjacent wall surface, screw-attach short flange of furring channel to web of attached channel. At interior corners, space second member no more than 12 inches from corner and cut insulation to fit.

F. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.

## 3.7 INSTALLING TRIM ACCESSORIES

A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.

B. Control Joints: Install control joints according to ASTM C 840 and in specific locations approved by Architect for visual effect.

C. Interior Trim: Install in the following locations:

1. Cornerbead: Use at outside corners, unless otherwise indicated.

## 3.8 FINISHING GYPSUM BOARD

A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.

B. Prefill open joints, rounded or beveled edges, and damaged surface areas.

C. Apply joint tape over gypsum board joints, except those with trim having flanges not intended for tape.

D. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C 840:

1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
2. Level 2: Where indicated on Drawings.
3. Level 3: Where indicated on Drawings.
4. Level 4: At panel surfaces that will be exposed to view, unless otherwise indicated.

    a. Primer and its application to surfaces are specified in other Division 09 Sections.

## 3.9 PROTECTION

A. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.

B. Remove and replace panels that are wet, moisture damaged, and mold damaged.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 092900

# SECTION 099123 - INTERIOR PAINTING

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section includes surface preparation and the application of paint systems on interior substrates.

B. Primers listed in Paint Schedule are in addition to shop-applied primers specified in other Sections.

### 1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include preparation requirements and application instructions.

B. Samples for Initial Selection: For each type of topcoat product.

C. Samples for Verification: For each type of paint system and in each color and gloss of topcoat.

1. Submit Samples on rigid backing, 8 inches square.
2. Step coats on Samples to show each coat required for system.
3. Label each coat of each Sample.
4. Label each Sample for location and application area.

D. Product List: For each product indicated, include the following:

1. Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules.
2. VOC content.

E. Alternative paint manufacturers and products requested for approval. Show equal products by comparison with Basis of Design products.

## 1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Paint: 5 percent, but not less than 1 gal. of each material and color applied.

## 1.5 QUALITY ASSURANCE

A. Mockups: Apply mockups of each paint system indicated and each color and finish selected to verify preliminary selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Architect will select one surface to represent surfaces and conditions for application of each paint system specified in Part 3.

a. Vertical and Horizontal Surfaces: Provide samples of at least 100 sq. ft.
b. Other Items: Architect will designate items or areas required.

2. Final approval of color selections will be based on mockups.

a. If preliminary color selections are not approved, apply additional mockups of additional colors selected by Architect at no added cost to Owner.

3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

## 1.6 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.

## 1.7 FIELD CONDITIONS

A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.

B. Do not apply paints when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide The Sherwin Williams Co. or comparable product by one of the following:

1. Glidden Professional.
2. Benjamin Moore & Co.
3. Duron, Inc.

### 2.2 PAINT, GENERAL

A. Material Compatibility:

1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.

B. VOC Content: Products shall comply with VOC limits of authorities having jurisdiction and, for interior paints and coatings applied at Project site, the following VOC limits, exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

1. Flat Paints and Coatings: 50 g/L.
2. Nonflat Paints and Coatings: 150 g/L.
3. Dry-Fog Coatings: 400 g/L.
4. Primers, Sealers, and Undercoaters: 200 g/L.
5. Anticorrosive and Antirust Paints Applied to Ferrous Metals: 250 g/L.
6. Zinc-Rich Industrial Maintenance Primers: 340 g/L.
7. Pretreatment Wash Primers: 420 g/L.
8. Floor Coatings: 100 g/L.
9. Shellacs, Clear: 730 g/L.
10. Shellacs, Pigmented: 550 g/L.

### 2.3 SOURCE QUALITY CONTROL

A. Testing of Paint Materials: Owner reserves the right to invoke the following procedure:

1. Owner will engage the services of a qualified testing agency to sample paint materials. Contractor will be notified in advance and may be present when samples are taken. If paint materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed, and certified by testing agency.
2. Testing agency will perform tests for compliance with product requirements.
3. Owner may direct Contractor to stop applying coatings if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Contractor will be required to remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints are incompatible.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:

1. Concrete: 12 percent.
2. Masonry (Clay and CMU): 12 percent.
3. Gypsum Wallboard: 12 percent.

C. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.

D. Proceed with coating application only after unsatisfactory conditions have been corrected.

1. Application of coating indicates acceptance of surfaces and conditions.

### 3.2 INSPECTION

A. Thoroughly examine surfaces scheduled to be painted prior to commencement of work. Report in writing any condition that may affect proper application. Do not commence work until such defects have been corrected.

B. Where materials are being applied over previously painted surfaces or questionable surfaces, apply samples and perform in place test to check for compatibility, adhesion

and film integrity of new materials to existing painted surfaces. Report in writing any condition that may affect application, appearance or performance of the paint.

C. Painting of surface constitutes contractor's acceptance of surface and responsibility for any paint failure.

## 3.3 PREPARATION

A. Comply with manufacturer's written instructions and recommendations applicable to substrates indicated.

B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.

1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.

1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.

D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.

E. Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces or mortar joints exceed that permitted in manufacturer's written instructions.

F. Steel Substrates: Remove rust, loose mill scale, and shop primer, if any. Clean using methods recommended in writing by paint manufacturer but not less than the following:

1. SSPC-SP 2, "Hand Tool Cleaning."
2. SSPC-SP 3, "Power Tool Cleaning."

G. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.

H. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal fabricated from coil stock by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.

I. Wood Substrates:

1. Scrape and clean knots, and apply coat of knot sealer before applying primer.
2. Sand surfaces that will be exposed to view, and dust off.
3. Prime edges, ends, faces, undersides, and backsides of wood.
4. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.

## 3.4 APPLICATION

A. Apply paints according to manufacturer's written instructions and to recommendations.

1. Use applicators and techniques suited for paint and substrate indicated.
2. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
3. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
4. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
5. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.

B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.

C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.

D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

E. Painting Fire Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:

1. Paint the following work where exposed in equipment rooms:

a. Equipment, including panelboards and switch gear.
b. Uninsulated metal piping.
c. Uninsulated plastic piping.
d. Pipe hangers and supports.
e. Metal conduit.
f. Plastic conduit.
g. Tanks that do not have factory-applied final finishes.

h. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.

2. Paint the following work where exposed in occupied spaces:

a. Equipment, including panelboards.
b. Uninsulated metal piping.
c. Uninsulated plastic piping.
d. Pipe hangers and supports.
e. Metal conduit.
f. Plastic conduit.
g. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
h. Other items as directed by Architect.

3. Paint portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets that are visible from occupied spaces.

## 3.5 FIELD QUALITY CONTROL

A. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.

1. Contractor shall touch up and restore painted surfaces damaged by testing.
2. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written recommendations.

## 3.6 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.7 SCHEDULE - INTERIOR SURFACES – LATEX (Low VOC. Meets Federal OTC regulations)

A. Refer to “Interior Finishes” on drawings for additional information.

B. Shop Primed Ferrous Metal: Semi-Gloss Latex:

1. Sherwin-Williams:

a. Primer: Compatible type recommended by the finish coat manufacturer.
b. Finish: Two coats ProMar 200 Interior Latex Semi-Gloss B28 W200.

C. Ferrous Metal: Semi-Gloss Latex:

1. Sherwin-Williams:

a. Primer: One coat DTM Acrylic B66 Primer/Finish Paint.
b. Finish: Two coats ProMar 200 Interior Latex Semi-Gloss.

D. Galvanized Metals: Semi-Gloss Latex: Pretreat as required by manufacturer.

1. Sherwin-Williams:

a. Primer: One coat DTM Acrylic B66 Primer/Finish Paint.
b. Finish: Finish: Two coats ProMar 200 Interior Latex Semi-Gloss.

E. Concrete Masonry Units: Semi-Gloss Latex:

1. Sherwin-Williams:

a. Filler: One coat Prep Rite Block Filler B25 W25.
b. Finish: Two coats ProMar 200 Interior Latex Semi-Gloss.

F. Gypsum Board: Eggshell Latex:

1. Sherwin-Williams:

a. Primer: One coat PrepRite 200 Latex Wall Primer (B28 W200).
b. Finish: Two coats ProMar 200 Latex Egg-Shell Enamel B20.

END OF SECTION 099123

# SECTION 101423 – BUILDING SIGNAGE

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Panel signs. see University of Maryland Sign Master Plan – dated February 2012.
2. Wall Mounted identification: Type-B. Porcelain enamel sign 3’-6” wide by 3’-0” high.

B. Related Requirements:

1. Section 101423.16 "Room-Identification Panel Signage" for room-identification signs that are directly attached to the building.
2. Section 265213 "Emergency and Exit Lighting" for illuminated, self-luminous, and photoluminescent exit sign units.

### 1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For panel signs.

1. Include fabrication and installation details and attachments to other work.
2. Show sign mounting heights, locations of supplementary supports to be provided by other installers, and accessories.
3. Show message list, typestyles, graphic elements, and layout for each sign at least half size.
4. Include diagrams for power, signal, and control wiring.

C. Samples: For each exposed product and for each color and texture specified.

### 1.3 CLOSEOUT SUBMITTALS

A. Maintenance data.

### 1.4 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design sign structure and anchorage of sign type(s) according to structural performance requirements.

B. Structural Performance: Signs and supporting elements shall withstand the effects of gravity and other loads within limits and under conditions indicated.

C. Thermal Movements: For exterior signs, allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

D. Accessibility Standard: Comply with applicable provisions in the USDOJ's "2010 ADA Standards for Accessible Design".

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 PANEL SIGNS

A. Panel Sign: Sign with smooth, uniform surfaces; with message and characters having uniform faces, sharp corners, and precisely formed lines and profiles; and as follows:

2.3 PANEL-SIGN MATERIALS

A. Porcelain enamel sign 3’-6” wide by 3’-0” high.

2.4 ACCESSORIES

A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of signs, noncorrosive and compatible with each material joined, and complying with the following unless otherwise indicated:
1. Exposed Metal-Fastener Components, General:

a. Fabricated from same basic metal and finish of fastened metal unless otherwise indicated.

B. Post-Installed Anchors: Fastener systems with bolts of same basic metal as fastened metal, if visible, unless otherwise indicated; with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC01 as appropriate for the substrate.

1. Uses: Securing signs with imposed loads to structure.
2. Type: Torque-controlled, expansion anchor.

3. Material for Exterior or Interior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 stainless-steel bolts, ASTM F 593, and nuts, ASTM F 594.

C. Power-Actuated Anchors: Fastener systems with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

D. Adhesive: As recommended by sign manufacturer.

E. Two-Face Tape: Manufacturer's standard high-bond, foam-core tape, 0.045 inch thick, with adhesive on both sides.

F. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187/D 1187M.

## 2.5 FABRICATION

A. General: Provide manufacturer's standard sign assemblies according to requirements indicated.

1. Mill joints to a tight, hairline fit. Form assemblies and joints exposed to weather to resist water penetration and retention.
2. Provide welds and brazes behind finished surfaces without distorting or discoloring exposed side. Clean exposed welded and brazed connections of flux, and dress exposed and contact surfaces.
3. Conceal connections if possible; otherwise, locate connections where they are inconspicuous.
4. Internally brace signs for stability, to meet structural performance loading without oil-canning or other surface deformation, and for securing fasteners.
5. Provide rabbets, lugs, and tabs necessary to assemble components and to attach to existing work. Drill and tap for required fasteners. Use concealed fasteners where possible; use exposed fasteners that match sign finish.

B. Subsurface-Applied Graphics: Apply graphics to back face of clear face-sheet material to produce precisely formed image. Image shall be free of rough edges.

C. Shop- and Subsurface-Applied Vinyl: Align vinyl film in final position and apply to surface. Firmly press film from the middle outward to obtain good bond without blisters or fishmouths.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

A. General: Install signs using mounting methods indicated and according to manufacturer's written instructions.

1. Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
2. Install signs so they do not protrude or obstruct according to the accessibility standard.

3. Before installation, verify that sign surfaces are clean and free of materials or debris that would impair installation.
4. Corrosion Protection: Coat concealed surfaces of exterior aluminum in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

B. Mounting Methods:

1. Through Fasteners: Drill holes in substrate using predrilled holes in sign as template. Countersink holes in sign if required. Place sign in position and flush to surface. Install through fasteners and tighten.

C. Remove temporary protective coverings and strippable films as signs are installed.

END OF SECTION 101423

# SECTION 101423.16 - ROOM-IDENTIFICATION PANEL SIGNAGE

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section includes room-identification signs for all interior rooms as indicated on the Architectural drawings.

### 1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For room-identification signs.

1. Include fabrication and installation details and attachments to other work.
2. Show sign mounting heights, locations of supplementary supports to be provided by other installers, and accessories.
3. Show message list, typestyles, graphic elements, including raised characters and Braille, and layout for each sign at least half size.

C. Samples: For each exposed product and for each color and texture specified. Specify that a sample of the typical interior room sign shall be submitted to OFM for approval prior to fabrication of signs for all projects.

### 1.3 INFORMATIONAL SUBMITTALS

A. Sample warranty.

### 1.4 CLOSEOUT SUBMITTALS

A. Maintenance data.

### 1.5 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

## 2.1 PERFORMANCE REQUIREMENTS

A. Accessibility Standard: Comply with applicable provisions in the USDOJ's "2010 ADA Standards for Accessible Design".

## 2.2 ROOM-IDENTIFICATION SIGNS

A. Interior Graphic Images: The design of the interior graphic images for directories, room signs, special purpose signs, and other signs, shall consist of:
   1. Characters and symbols shall contrast with their background achieved by a single brushed or matte silver-colored field with black text in initial capitalized Futura Book style. Both the characters and the background of the signs shall have a non-glare finish.
   2. Except on directories, which should be justified left with numbers justified right, all numbers and texts shall be centered.
   3. All signs shall be frameless and corners shall be essentially square with a slightly eased edge (rather than sharp), in sizes as indicated on the drawings.
   4. Tactile Characters: 1/16 inch rigid, Rowmark ADA Black (#311-401) or similar material. Type face shall be Futura Book ACCT,A.K.REV.F (Manufactured by Gerber Scientific for Omega Software).
   5. Americans with Disabilities Act (ADA) Requirements: For room identification signs, contrasting raised characters are set into and chemically bonded into computer routed slots. Braille captions are set into the sign surface, and are centered directly below the tactile text, both under the room number and room name. The face of all characters shall be raised a minimum of 1/32 inch, or as determined by current ADA Standards, from the surface of the sign.
      a. Braille: Braille used in ADA Signage shall be “Grade II” conforming to specification #800, National Library Service, Library of Congress:
      b. The height of braille dots shall be a uniform .025 inches.
      c. The base diameter of braille dots shall be .059 inches.
      d. Cell spacing of dots shall conform to the following:
         1) The nominal distance from center to center of adjacent dots (horizontally or vertically, but not diagonally) within the same cell shall be .092 inches.
         2) The nominal distance from center to center of corresponding dots in adjacent cells shall be .245 inches.
         3) The nominal line spacing of braille cells from center to center of nearest corresponding dots in adjacent lines shall be .400 inches.
      e. Mounting shall be consistent with ADA regulated clearances on the wall adjacent to the latch side of the door. Signs shall be mounted so that the centerline of the sign is sixty (60) inches above the finished floor, and the mounting location for signs shall ensure that a visually impaired person may approach within three (30 inches of the sign without encountering protruding objects or an out swinging door.
   6. Room Identification Signs: UM utilizes several types of room identification signs.
      a. Type “G” General Room Identification Signs: These signs types are used for room identification. These sign types shall be provided in accordance with the requirements of applicable building codes and the ADA.

1) Type G.01 Room Number and Braille Onl: These signs are used for rooms that do not require additional identification, such as some research labs, storage closets, and janitor closets.
   a) Size: 2.5 inches high by 6 inches wide.
2) Type C.02 Unisex Restroom Signs: These signs shall be 6 inches wide by 9 inches high so that a 6 inch by 6 inch field at the bottom of the sign is available for the international symbols. The male and female figures shall be (4) inches high located one (1) inch above the bottom and centered with a vertical bar separating the figures. If the room is accessible to the mobility impaired, then the international symbol of accessibility also shall be used. This symbol shall be 1.25 inches high.
3) Type C.03 Signs: These signs shall be 6 inches wide by 9 inches high, with tactile "STAIR" with Braille and associated stair symbol.
4) Type F.01 Evacuation Plan Signs: These signs are located throughout the building by the University Fire Marshall as directed by the UM OFM Project Manager. The signs are sized to hold an 8.5 inch by 11 inch sheet of paper in a window insert.
   a) Size: 12 inches by 12 inches wide.

## 2.3 SIGN MATERIALS

A. Materials: ¼ inch rigid, clear acrylic with screen printed or painted silver finish on back, Pantone #877c. Cut edges are not to be polished.

## 2.4 ACCESSORIES

A. Adhesive: As recommended by sign manufacturer.

B. Two-Face Tape: Manufacturer's standard high-bond, foam-core tape, 0.045 inch thick, with adhesive on both sides.

## 2.5 FABRICATION

A. General: Provide manufacturer's standard sign assemblies according to requirements indicated.

1. Mill joints to a tight, hairline fit. Form assemblies and joints exposed to weather to resist water penetration and retention.
2. Conceal connections if possible; otherwise, locate connections where they are inconspicuous.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

A. General: Install signs using mounting methods indicated and according to manufacturer's written instructions.

1. Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
2. Install signs so they do not protrude or obstruct according to the accessibility standard.
3. Before installation, verify that sign surfaces are clean and free of materials or debris that would impair installation.

B. Mounting Methods:
1. Adhesive: Clean bond-breaking materials from substrate surface and remove loose debris. Apply linear beads or spots of adhesive symmetrically to back of sign and of suitable quantity to support weight of sign after cure without slippage. Keep adhesive away from edges to prevent adhesive extrusion as sign is applied and to prevent visibility of cured adhesive at sign edges. Place sign in position, and push to engage adhesive. Temporarily support sign in position until adhesive fully sets.
2. Two-Face Tape: Clean bond-breaking materials from substrate surface and remove loose debris. Apply tape strips symmetrically to back of sign and of suitable quantity to support weight of sign without slippage. Keep strips away from edges to prevent visibility at sign edges. Place sign in position, and push to engage tape adhesive.

END OF SECTION 101423.16

# SECTION 102800 - TOILET, BATH, AND LAUNDRY ACCESSORIES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Public-use washroom accessories.
2. Underlavatory guards.
3. Custodial accessories.

### 1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

### 1.3 INFORMATIONAL SUBMITTALS

A. Sample warranty.

### 1.4 CLOSEOUT SUBMITTALS

A. Maintenance data.

### 1.5 WARRANTY

A. Manufacturer's Special Warranty for Mirrors: Manufacturer agrees to repair or replace mirrors that fail in materials or workmanship within specified warranty period.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

### 2.2 PUBLIC-USE WASHROOM ACCESSORIES

A. Toilet Tissue (Roll) Dispenser:

1. Manufacturers:

a. SanJamar: Double junior jumbo roll nine (9) inch toilet tissue dispenser number "4500 TBK"
b. Kimberly Clark: JRT junior twin roll toilet tissue dispenser number "09551" Smoke Grey finish or number "09552" White finish.

2. Description: Double-roll dispenser.
3. Mounting: Surface mounted.
4. Operation: Noncontrol delivery with standard spindle.
5. Capacity: Designed for 4-1/2- or 5-inch- diameter tissue rolls.
6. Material and Finish: Chrome-plated zinc alloy (zamac) or steel.

B. Paper Towel Dispenser:

1. Manufacturer: Kimberly Clark "Sanitouch" roll type towel dispenser with one of the following finishes:

a. Number "09991" Pearl White Finish
b. Number "09990" Smoke Grey Finish

C. Break Area Paper Towel Dispenser:

1. Kimberly Clark type Omni roll towel dispenser "09746" Smoke Finish.

D. Trash Containers:

1. Specify free standing grey molded plastic trash cans with a 23 gallon capacity, approximate size 20 inches long x 11 inches wide x 30 inches high, Rubbermaid Slim Jim Container, Model #3540.

E. Liquid-Soap Dispenser:
1. Manufacturer:

a. Bobrick: Number "B-40" surface mounted.
b. Bobrick: Number "B-822" deck mounted.

2. Description: Designed for dispensing soap in liquid or lotion form.
3. Mounting: Deck mounted, surface mounted.

F. Grab Bar:

1. Mounting: Flanges with concealed fasteners.
2. Material: Satin stainless steel, 0.05 inch thick.

a. Finish: Smooth, No. 4 finish (satin) on ends and slip-resistant texture in grip area.

3. Outside Diameter: 1-1/2 inches.
4. Configuration and Length: As indicated on Drawings.

G. Sanitary-Napkin Disposal Unit:

1. Mounting: Surface mounted.
2. Door or Cover: Self-closing, disposal-opening cover and hinged face panel with tumbler lockset.
3. Receptacle: Removable.
4. Material and Finish: Chrome.

H. Mirror Unit:

1. Clear polished plate mirror, 20 gauge galvanized steel back, stainless steel retainer angle, concealed wall hanger and theft resistant locking screws.

2. Size: 24 inches wide x 36 inches high x 1/4 inches thick.

I. Coat Hook:

1. Description: Heavy gauge stainless steel with a concealed wall plate, with no exposed fasteners.
2. Material and Finish: Polished chrome-plated zinc alloy (zamac).

J. Shelf:

1. Heavy gauge stainless steel, eight (8) inch projection, with rolled edges and concealed surface mounting anchors.

## 2.3 UNDERLAVATORY GUARDS

A. Underlavatory Guard:

1. Description: Insulating pipe covering for supply and drain piping assemblies that prevents direct contact with and burns from piping; allow service access without removing coverings.
2. Material and Finish: Antimicrobial, molded plastic, white.

## 2.4 CUSTODIAL ACCESSORIES

A. Mop and Broom Holder: Storage Room 23

1. Description: Unit with shelf, hooks, holders, and rod suspended beneath shelf.
2. Length: 36 inches. Hooks: Four.
3. Mop/Broom Holders: Three, spring-loaded, rubber hat, cam type.
4. Material and Finish: Stainless steel, No. 4 finish (satin).

    a. Shelf: Not less than nominal 0.05-inch-thick stainless steel.
    b. Rod: Approximately 1/4-inch-diameter stainless steel.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install accessories according to manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.

B. Grab Bars: Install to withstand a downward load of at least 250 lbf, when tested according to ASTM F 446.

END OF SECTION 102800

# SECTION 104416 - FIRE EXTINGUISHERS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section includes portable, hand-carried fire extinguishers wall-mounted on bracket.

### 1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

### 1.3 INFORMATIONAL SUBMITTALS

A. Warranty: Sample of special warranty.

### 1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

### 1.5 COORDINATION

A. Coordinate type and capacity of fire extinguishers with fire-protection cabinets to ensure fit and function.

### 1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Six years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."

B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.

2.2 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

A. Fire Extinguishers: Type, size, and capacity for each fire-protection cabinet indicated.

Oval Brand Fire Products. ABC dry chemical, Model #10JABC. 22”H x 11” W x 3” D.

B. Regular Dry-Chemical Type: UL-rated nominal capacity, with sodium bicarbonate-based dry chemical in manufacturer's standard enameled container.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Examine fire extinguishers for proper charging and tagging.

1. Remove and replace damaged, defective, or undercharged fire extinguishers.

B. Install fire extinguishers in locations indicated and in compliance with requirements of authorities having jurisdiction.

END OF SECTION 104416

# SECTION 105113 - METAL LOCKERS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Welded corridor lockers. As indicated on the Architectural drawings.

### 1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each color specified.

### 1.3 INFORMATIONAL SUBMITTALS

A. Sample warranty.

### 1.4 CLOSEOUT SUBMITTALS

A. Maintenance data.

### 1.5 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of metal lockers that fail in materials or workmanship, excluding finish, within specified warranty period.
1. Warranty Period for Welded Metal Lockers: Lifetime from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

A. Accessibility Standard: For lockers indicated to be accessible, comply with applicable provisions in the USDOJ's "2010 ADA Standards for Accessible Design".

2.2 WELDED CORRIDOR LOCKERS

A. Doors: One piece; fabricated from 0.075-inch nominal-thickness steel sheet; formed into channel shape with double bend at vertical edges and with right-angle single bend at horizontal edges.

1. Reinforcement: Manufacturer's standard reinforcing angles, channels, or stiffeners for doors more than 15 inches wide; welded to inner face of doors.
2. Door Style: Unperforated panel.

B. Body: Assembled by welding body components together. Fabricate from unperforated steel sheet with thicknesses as follows:

1. Tops, Bottoms, and Sides: 0.060-inch nominal thickness.
2. Backs: 0.048-inch nominal thickness.
3. Shelves: 0.060-inch nominal thickness, with double bend at front and single bend at sides and back.

C. Frames: Channel formed; fabricated from 0.060-inch nominal-thickness steel sheet; lapped and factory welded at corners; with top and bottom main frames factory welded into vertical main frames. Form continuous, integral, full-height door strikes on vertical main frames.

D. Hinges:
1. Hinges: Manufacturer's standard, steel, continuous or knuckle type.

E. Projecting Door Handle and Latch: Finger-lift latch control designed for use with either built-in combination locks or padlocks; positive automatic latching, chromium plated; pry and vandal resistant.

1. Latch Hooks: Equip doors 48 inches and higher with three latch hooks and doors less than 48 inches high with two latch hooks; fabricated from 0.105-inch nominal-thickness steel sheet; welded or riveted to full-height door strikes; with resilient silencer on each latch hook.
2. Latching Mechanism: Manufacturer's standard, rattle-free latching mechanism and moving components isolated to prevent metal-to-metal contact, and incorporating a prelocking device that allows locker door to be locked while door is open and then closed without unlocking or damaging lock or latching mechanism.

F. Door Handle and Latch for Box Lockers: Stainless steel strike plate with integral pull; with steel padlock loop that projects through metal locker door.

G. Identification Plates: Manufacturer's standard, etched, embossed, or stamped aluminum plates, with numbers and letters at least 3/8 inch high.

H. Hooks: Manufacturer's standard ball-pointed, aluminum or steel; zinc plated.

I. Legs: 6 inches high; formed by extending vertical frame members, or fabricated from 0.075-inch nominal-thickness steel sheet; welded to bottom of locker.

1. Provide closed front and end bases.

J. Continuous Sloping Tops: Fabricated from 0.048-inch nominal-thickness steel sheet, with a pitch of approximately 20 degrees.

1. Closures: Vertical-end type.

K. Recess Trim: Fabricated from 0.048-inch nominal-thickness steel sheet.

L. Filler Panels: Fabricated from 0.048-inch nominal-thickness steel sheet.

M. Boxed End Panels: Fabricated from 0.048-inch nominal-thickness steel sheet.

N. Finished End Panels: Fabricated from 0.024-inch nominal-thickness steel sheet to cover unused penetrations and fasteners, except for perimeter fasteners, at exposed ends of nonrecessed metal lockers; finished to match lockers.

O. Materials:

1. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Commercial Steel (CS), Type B, suitable for exposed applications.
2. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B; with A60 zinc-iron, alloy (galvannealed) coating designation.

P. Finish: Baked enamel or powder coat.

1. Color: As selected by Architect from manufacturer's full range.

## 2.3 FABRICATION

A. Fabricate metal lockers square, rigid, without warp, and with metal faces flat and free of dents or distortion. Make exposed metal edges safe to touch and free of sharp edges and burrs.

B. Fabricate each metal locker with an individual door and frame; individual top, bottom, and back; and common intermediate uprights separating compartments.

C. Equipment: Provide each locker with an identification plate and the following equipment:

1. Single-Tier Units: Shelf, one double-prong ceiling hook, and two single-prong wall hooks.
2. Double-Tier Units: One double-prong ceiling hook and two single-prong wall hooks.
3. Triple-Tier Units: One double-prong ceiling hook.
4. Coat Rods: [**As indicated on Drawings**] [**For each compartment of each locker**] [**In lieu of ceiling hook for metal lockers 24 inches high or more**] [**In lieu of ceiling hook for metal lockers 18 inches deep or more**].

D. Welded Construction: Factory preassemble metal lockers by welding all joints, seams, and connections; with no bolts, nuts, screws, or rivets used in assembly of main locker groups. Factory weld main locker groups into one-piece structures. Grind exposed welds smooth and flush.

E. Accessible Lockers: Fabricate as follows:

1. Locate bottom shelf no lower than 15 inches above the floor.
2. Where hooks, coat rods, or additional shelves are provided, locate no higher than 48 inches above the floor.

F. Continuous Sloping Tops: Fabricated in lengths as long as practical, without visible fasteners at splice locations; finished to match lockers.

G. Recess Trim: Fabricated with minimum 2-1/2-inch face width and in lengths as long as practical; finished to match lockers.

H. Filler Panels: Fabricated in an unequal leg angle shape; finished to match lockers. Provide slip-joint filler angle formed to receive filler panel.

I. Boxed End Panels: Fabricated with 1-inch- wide edge dimension, and designed for concealing fasteners and holes at exposed ends of nonrecessed metal lockers; finished to match lockers.

J. Finished End Panels: Fabricated to conceal unused penetrations and fasteners, except for perimeter fasteners, at exposed ends of nonrecessed metal lockers; finished to match lockers.

K. Center Dividers: Full-depth, vertical partitions between bottom and shelf; finished to match lockers.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install lockers level, plumb, and true; shim as required, using concealed shims.

1. Anchor locker runs at ends and at intervals recommended by manufacturer, but not more than 36 inches o.c. Using concealed fasteners, install anchors through backup reinforcing plates, channels, or blocking as required to prevent metal distortion.
2. Anchor single rows of metal lockers to walls near top [**and bottom of lockers**] [**of lockers and to floor**].

B. Welded Lockers: Connect groups together with manufacturer's standard fasteners, with no exposed fasteners on face frames.

C. Trim: Fit exposed connections of trim, fillers, and closures accurately together to form tight, hairline joints, with concealed fasteners and splice plates.

1. Attach recess trim to recessed metal lockers with concealed clips.
2. Attach filler panels with concealed fasteners.
3. Attach sloping-top units to metal lockers, with closures at exposed ends.
4. Attach boxed end panels using concealed fasteners to conceal exposed ends of nonrecessed metal lockers.
5. Attach finished end panels using fasteners only at perimeter to conceal exposed ends of nonrecessed metal lockers.

END OF SECTION 105113

# SECTION 111319 - STATIONARY LOADING DOCK EQUIPMENT

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Stationary loading equipment.

2. Rolling Safety Gate. (Loading Dock overhead door and Hoistway 2nd Floor door)

### 1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each exposed product and for each color and texture specified.

### 1.3 WARRANTY

A. Dock Levelers:

1. Structural Assembly: 10 years.
2. Hydraulic System: Four years.

### 1.4 MAINTENANCE SERVICE

A. Full-Maintenance Service: 12 months.

### 1.5 PRODUCTS

A. Recessed Loading Dock Levelers: MH 30.1. Model “H” as manufactured by Blue Giant. Recessed, pit installed hinged dock leveler. Electro-hydraulically operated with independent control of deck and lip complete with hydraulic lip and deck cylinders and rear fixed hinge with 4 inches lateral ramp flex. Pit depth: front 20 inches and rear 19.5”. Deck length includes 16 inches lip.

1. Rated Capacity: 40,000 lb.
2. Platform Size:

   a. Pit Width: 72 inches
   b. Pit Length: 63 inches.

3. Frame: Standard type.
4. Toe-Guard Range: Entire upper operating range.

5. Automatic Compensation: Vertical and lateral.
6. Length of Lip Extension: Not less than 16 inches measured from ramp edge.
7. Operation: Hydraulic.
8. Integral Molded-Rubber Dock Bumpers: 4 inches thick.
9. Accessories:

    a. Curb angles.
    b. Side and rear weatherseals.
    c. Foam-insulated deck.
    d. Abrasive skid-resistant surface.

10. Finish: Hot-dip galvanized.

1.6 Rolling Safety Gate: Diversified Fall Protection, 24400 Sperry Drive, Westlake, Ohio 44145, Lorgate Loading Dock Safety LORGATE Rolling Safety Gate, with standard, safety yellow powder-coated finish provides long service life and high visibility in busy, loading dock areas. LORGATE rolling safety gate systems meet OSHA 1910 general industry requirements and come complete with 1 locking pin, floor mounted swivel assembly with bushing sleeve, pivot caster wheel, and a screw anchor kit. Available in 6', 8', 10', and 12' lengths. Fits standard 6’ 8, 10’ and 12’ dock doors. Tested to OSHA regulations: Can withstand 200 lb. force at the top rail 42” and 150 lb. force at the mid-rail 21”. Easy to use – rolling wheel design eliminates lifting and trip / pinch hazards.

END OF SECTION 111319

# SECTION 113013 - RESIDENTIAL APPLIANCES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Refrigeration appliances.

2. Microwave- countertop model.

### 1.2 INFORMATIONAL SUBMITTALS

A. Product certificates.

B. Field quality-control reports.

C. Sample warranties.

### 1.3 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

### 1.4 WARRANTY

A. Special Warranties: Manufacturer agrees to repair or replace residential appliances or components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 REFRIGERATOR/FREEZERS

A. Refrigerator/Freezer: Two-door refrigerator/freezer with freezer on top and complying with AHAM HRF-1.

1. Type: GE 15.5 cubic foot top mount refrigerator. Energy Star compliant. GTE16DTHBB.

2. General Features:

a. Dispenser inside of freezer for ice.

b. Interior light in refrigeration compartment.
c. Manual defrost.
d. Interior light in freezer compartment.

3. ENERGY STAR: Provide appliances that qualify for the EPA/DOE ENERGY STAR product-labeling program.
4. Front Panel(s): Manufacturer's standard.

B. Microwave – Countertop Model: GE 2.0 cubic feet countertop microwave. Stainless steel. GEJES205ISNSS.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Freestanding Equipment: Place units in final locations after finishes have been completed in each area. Verify that clearances are adequate to properly operate equipment.

### 3.2 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Perform visual, mechanical, and electrical inspection and testing for each appliance according to manufacturers' written recommendations. Certify compliance with each manufacturer's appliance-performance parameters.
2. Operational Test: After installation, start units to confirm proper operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and components.

B. An appliance will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION 113013

# SECTION 122413 - ROLLER WINDOW SHADES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Manually operated woven mesh roller shades with single rollers. (Used at windows in Toilet 12 and Break 22 rooms only).

2. Commercial-grade for heavy-duty use.

### 1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each exposed product and for each color and texture specified.

### 1.3 INFORMATIONAL SUBMITTALS

A. Product certificates.

B. Product test reports.

### 1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

### 1.5 QUALITY ASSURANCE

A. Installer Qualifications: Fabricator of products.

B. Special Warranty Performance Requirements:
1. Tracks, gear and sprocket mechanism, and accessories for shades shall be warrantied for 5 years against defects in materials and workmanship which inhibit proper and intended functioning of products.
2. Shade cloth shall not deteriorate, sag or warp, and will remain fit for use for no less than 10 years.

C. Shop Drawings: Shall include assembly mounting details, position of shade in relationship to glass or frame surface, and special conditions at external and internal corners.

PART 2 - PRODUCTS

## 2.1 MANUFACTURERS

A. Source Limitations: Obtain roller shades from single source from single manufacturer.

## 2.2 MANUALLY OPERATED SHADES WITH SINGLE ROLLERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. MechoShade Systems, Inc. Mecho/5 Manual Shade System.

2. Vimco

B. Chain-and-Clutch Operating Mechanisms: With continuous-loop bead chain and clutch that stops shade movement when bead chain is released; permanently adjusted and lubricated.

1. Chain-Retainer Type: Clip, jamb mount.
2. Spring Lift-Assist Mechanisms: Provide for shadebands that weigh more than 10 lb or for shades as recommended by manufacturer, whichever criterion is more stringent.
3. Chain shall be #10 stainless steel bead chain formed in a continuous loop. Chain operator shall be long enough to ensure easy operation. Plastic hem grips are not used.

C. Crank-and-Gear Operating Mechanisms: Sealed gearbox drive system controlled by detachable crank handle.

D. Rollers: Corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shadebands indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shadebands for service.

1. Roller Drive-End Location: Right side of interior face of shade.
2. Direction of Shadeband Roll: Regular, from back (exterior face) of roller.

E. Mounting Hardware: Brackets or endcaps, corrosion resistant and compatible with roller assembly, operating mechanism, installation accessories, and mounting location and conditions indicated. Support hardware shall be capable of supporting 150% of the full weight of each shade. Shall be adjustable for exterior of shade unit without disassembly of hardware, and shall have a built-in shock absorber system to prevent chain breakage under normal useage.

F. Roller-Coupling Assemblies: Coordinated with operating mechanism and designed to join up to three inline rollers into a multiband shade that is operated by one roller drive-end assembly.

G. Shadebands:

1. Shadeband Material: Light-filtering fabric.
2. Shadeband Bottom (Hem) Bar: Steel or extruded aluminum.

a. Type: Enclosed in sealed pocket of shadeband material.

b. Color and Finish: As selected by Architect from manufacturer's full range.

H. Installation Accessories:

1. Front Fascia: Aluminum extrusion that conceals front and underside of roller and operating mechanism and attaches to roller endcaps without exposed fasteners. Shall be snap-on aluminum fascia or covered to match the shade cloth. Side and sill closure channels shall be provided between shade sides and window jambs and between hem bars and sills to match the valence.
2. Exposed Headbox: Rectangular, extruded-aluminum enclosure including front fascia, top and back covers, endcaps, and removable bottom closure.
3. Endcap Covers: To cover exposed endcaps.
4. Recessed Shade Pocket: Rectangular, extruded-aluminum enclosure designed for recessed ceiling installation; with front, top, and back formed as one piece, end plates, and removable bottom closure panel.
5. Closure Panel and Wall Clip: Removable aluminum panel designed for installation at bottom of site-constructed ceiling recess or pocket and for snap-in attachment to wall clip without fasteners.
6. Side Channels: With light seals and designed to eliminate light gaps at sides of shades as shades are drawn down. Provide side channels with shadeband guides or other means of aligning shadebands with channels at tops.
7. Bottom (Sill) Channel or Angle: With light seals and designed to eliminate light gaps at bottoms of shades when shades are closed.
8. Installation Accessories Color and Finish: As selected from manufacturer's full range.

## 2.3 SHADEBAND MATERIALS

A. Shadeband Material Flame-Resistance Rating: Comply with NFPA 701. Testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

B. Light-Filtering Fabric: Woven fabric, stain and fade resistant.

1. Source: Roller shade manufacturer.
2. Weave: Basketweave.
3. No seams and hang flat without buckling or distortion. Edge, when trimmed, shall hang straight without raveling.
4. Unguided roller shade cloth shall hang true and straight, without shifting sideways more than 1/8 inch in either direction due to warp distortion or weave design.
5. Area Coverage: Each shade shall fully cover the opening where it occurs. Breaks between the units are to only occur at mullions and other defined vertical separations for continuous installation.
6. Roll Width: 98 inches.
7. Orientation on Shadeband: Up the bolt.
8. Openness Factor: Opaque. 5 percent.
9. Color: As selected by Architect from manufacturer's full range.

## 2.4 ROLLER SHADE FABRICATION

A. Product Safety Standard: Fabricate roller shades to comply with WCMA A 100.1

B. Unit Sizes: Fabricate units in sizes to fill window and other openings as follows, measured at 74 deg F:

1. Between (Inside) Jamb Installation: Width equal to jamb-to-jamb dimension of opening in which shade is installed less 1/4 inch per side or 1/2-inch total, plus or minus 1/8 inch. Length equal to head-to-sill or -floor dimension of opening in which shade is installed less 1/4 inch, plus or minus 1/8 inch.

## PART 3 - EXECUTION

### 3.1 ROLLER SHADE INSTALLATION

A. Install roller shades level, plumb, and aligned with adjacent units according to manufacturer's written instructions.

B. Adjust and balance roller shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.

C. Clean roller shade surfaces, after installation, according to manufacturer's written instructions.

D. Replace damaged roller shades that cannot be repaired, in a manner approved by Architect, before time of Substantial Completion.

E. The Installer shall verify all field dimensions, install shades level and plumb, and ensure unencumbered operation of window sash hardware. Metal parts of shade units shall be isolated from concrete mortar to prevent galvanic action.

END OF SECTION 122413

# SECTION 123530 - RESIDENTIAL CASEWORK

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section includes kitchen cabinets.

### 1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For residential casework. Include plans, elevations, details, and attachments to other work.

C. Samples: For casework and hardware finishes.

### 1.3 INFORMATIONAL SUBMITTALS

A. Product Certificates: For casework.

## PART 2 - PRODUCTS

### 2.1 CABINETS

A. Quality Standard: Provide cabinets that comply with KCMA A161.1.

1. KCMA Certification: Provide cabinets with KCMA's "Certified Cabinet" seal affixed in a semiexposed location of each unit and showing compliance with KCMA A161.1.

B. Cabinet Bodies: ¾ inch thick veneer plywood with plain sawn oak veneer except where noted (AWI premium grade) and ½ inch thick solid red oak banding. Flor mounted fully enclosed with toe space.

C. Drawer Sides, Back and Front: ¾ inch thick veneer core plywood with oak veneer or ¾ inch thick solid oak wood.

D. Drawer Bottoms: Minimum 3/8 inch plywood or similar material.

E. Doors: ¾ inch thick, plain sliced red oak veneer plywood and ½ inch thick solid red oak banding.

F. Shelving: Shelving, exposed and in cabinets: ¾ inch thick x 12 inch deep plain sliced red oak veneer core plywood banded on exposed edges with a ½ inch thick solid red oak banding.

G. Pull or Handles: Round pulls, 5 inches long x 2.5 inches deep x 5/16 inch in diameter, and shall be ADA compliant. Knobs shall not be acceptable.

H. Wood Grain: Grain in adjacent panels shall be matched as to direction, color, and density. Wood grain shall be an all vertical pattern.

I. Drawer Slides: Drawer slides for drawers with a depth of seven inches or less shall be at minimum medium weight, full extension. Slides for drawers with a depth greater than seven inches shall be heavy duty, full extension hinges, and hardware on millwork shall be commercial grade.

## 2.2 CABINET HARDWARE

A. General: Manufacturer's standard units complying with BHMA A156.9, of type, size, style, material, and finish as selected by Architect from manufacturer's full range.

B. Cabinet hardware shall be furnished and installed by the cabinet fabricator so that a single responsibility is achieved. Pivot hinges, however, should be supplied and installed in the field because of their tendency to shift during setting and fitting of cabinets.
   1. All hardware shall be ADA compliant.
   2. Exposed hardware shall be finished either as brushed aluminum, staineless steel, or brushed chromium plate.
   3. Finish hardware for cabinets shall be installed at the factory.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

A. Install casework with no variations in adjoining surfaces; use concealed shims. Where casework abuts other finished work, scribe and cut for accurate fit. Provide filler strips, scribe strips, and moldings in finish to match casework.

B. Install casework without distortion so doors and drawers fit the openings, are aligned, and are uniformly spaced. Complete installation of hardware and accessories as indicated.

C. Install casework level and plumb to a tolerance of 1/8 inch in 8 feet.

D. Fasten casework to adjacent units and to backing.

   1. Fasten wall cabinets through back, near top and bottom, and at ends not more than 16 inches o.c.

      a. Fasteners: No. 10 wafer-head screws sized for not less than 1-1/2-inch penetration into wood framing, blocking, or hanging strips.

E. Adjust hardware so doors and drawers are centered in openings and operate smoothly without warp or bind. Lubricate operating hardware as recommended by manufacturer.

F. Clean casework on exposed and semiexposed surfaces. Touch up as required to restore damaged or soiled areas to match original factory finish, as approved by Architect.

END OF SECTION 123530

# SECTION 123661.16 - SOLID SURFACING COUNTERTOPS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Solid surface material countertops.
2. Solid surface material backsplashes.

### 1.2 ACTION SUBMITTALS

A. Product Data: For countertop materials.

B. Shop Drawings: For countertops. Show materials, finishes, edge and backsplash profiles, methods of joining, and cutouts for plumbing fixtures.

C. Samples: For each type of material exposed to view.

## PART 2 - PRODUCTS

### 2.1 SOLID SURFACE COUNTERTOP MATERIALS

A. Solid Surface Material: Homogeneous-filled plastic resin complying with ICPA SS-1.
1. Type: Provide Standard type unless Special Purpose type is indicated.
2. Colors and Patterns: As selected by Architect from manufacturer's full range.

B. Plywood: Exterior softwood plywood complying with DOC PS 1, Grade C-C Plugged, touch sanded.

### 2.2 COUNTERTOP FABRICATION

A. Fabricate countertops according to solid surface material manufacturer's written instructions and to the AWI/AWMAC/WI's "Architectural Woodwork Standards."

1. Grade: Premium.

B. Configuration:

1. Front: Straight, slightly eased at top.
2. Backsplash: Straight, slightly eased at corner.

C. Countertops: 3/4-inch- thick, solid surface material.

D. Backsplashes: 3/4-inch- thick, solid surface material.

E. Joints: Fabricate countertops without joints.

F. Cutouts and Holes:

1. Undercounter Plumbing Fixtures: Make cutouts for fixtures in shop using template or pattern furnished by fixture manufacturer. Form cutouts to smooth, even curves.

## 2.3 INSTALLATION MATERIALS

A. Adhesive: Product recommended by solid surface material manufacturer.

B. Sealant for Countertops: Comply with applicable requirements in Section 079200 "Joint Sealants."

# PART 3 - EXECUTION

## 3.1 INSTALLATION

A. Fasten countertops by screwing through corner blocks of base units into underside of countertop. Predrill holes for screws as recommended by manufacturer.

B. Fasten subtops to cabinets by screwing through subtops into cornerblocks of base cabinets. Shim as needed to align subtops in a level plane.

C. Secure countertops to subtops with adhesive according to solid surface material manufacturer's written instructions.

D. Bond joints with adhesive and draw tight as countertops are set. Mask areas of countertops adjacent to joints to prevent adhesive smears.

E. Install backsplashes and end splashes by adhering to wall and countertops with adhesive.

F. Complete cutouts not finished in shop. Mask areas of countertops adjacent to cutouts to prevent damage while cutting. Make cutouts to accurately fit items to be installed, and at right angles to finished surfaces unless beveling is required for clearance. Ease edges slightly to prevent snipping.

G. Apply sealant to gaps at walls; comply with Section 079200 "Joint Sealants."

END OF SECTION 123661.16

# SECTION 146400 - MONORAIL TROLLEY HOISTS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions, and other Division 1 Specification Section apply.

### 1.2 DESRCIPTION

A. This section includes requirements for furnishing all materials, equipment and appurtenances necessary for the complete and satisfactory installation of Monorail Trolley Hoist Systems as indicated in the drawings and in accordance with Contract Documents.

B. The Contractor shall provide materials and equipment necessary or incidental to the complete and satisfactory installation and performance of the Monorail Trolley Hoist Systems as listed below. The Contractor shall be responsible for the complete coordination of all work associated with the Monorail Manual Trolley Hoist Systems with the structural, and mechanical portions of the project. The Contractor shall be responsible for verifying all field conditions; headroom requirements, clearances, equipment weights and loading requirements and dimensions, and shall make whatever modifications are necessary to insure the proper installation and performance of the Monorail Manual Trolley Hoist Systems.

1. 5 Ton – Above the equipment hatch on the 2nd floor as indicated on the drawings.

C. Manufacturer of the Monorail Trolley Hoist Systems components shall have been in business for at least ten years and shall be an active member of the Hoist Manufacturer's Institute.

### 1.3 QUALITY ASSURANCE

A. Equipment furnished under this Section shall be a standard product of a manufacturer regularly engaged in the production of required materials and equipment. All equipment furnished shall, unless otherwise specified, conform to the applicable standards of the following organizations.

1. Crane Manufacturers Association of America, CMAA
2. OSHA

B. The Monorail Trolley Hoist specified in this Section shall be furnished, coordinated, serviced, and guaranteed by one supplier. The Monorail Trolley Hoist manufacturer shall provide a one-year warranty minimum on the hoist and equipment.

C. Monorail Trolley Hoist System shall be product of a single manufacturer provided from a single source that is a qualified manufacturer' sales, installation and service representative.

1. Monorail Manufacturers Association, MMA
2. Hoist Manufacturing Institute, HMI
3. Occupational Safety and Health Act, OSHA - CFR 29, OSHA - 1910.179
4. American National Standards Institute ANSI - B30.16 Std. for Hoists and ANSI MH-27 for Track Beams and ANSI-B30.11
5. American Society of Testing and Materials, ASTM Specifications for Structural Steel Shapes, Plates and Bars ASTM-A36 and Specifications for High-Strength Belts, Nuts and Washers. ASTM A 325
6. American Welding Society, AWS, Welding Procedures Appearance and Quality of Welds AWS D1.1
7. The Society for Protective Coatings, SSPC, for Shop and Field Metal Surface Preparation Finishing
8. American Institute of Steel Construction, AISC for Steel Fabrication and Construction
9. Industry Safety Orders, Article 92 - Hoists Auxiliary Hoisting Equipment and Hoisting Operations
10. American Society of Civil Engineers, ASCE 7-10

1.4 SUBMITTALS

A. Submit Contractor's Drawings and Shop Drawings in accordance with Division 1 - Submittal Procedures.

1. Complete description in sufficient detail to permit comparison with the technical specifications herein, including standard product technical data, installation instructions and detailed dimensioned drawings of equipment and its location relative to adjacent construction.
2. Capacities, weights and performance data.
3. Deviations from Drawings and Specifications.
4. Coordination Drawings indicating requirements for mechanical and electrical equipment with respect to load, lift, headroom equipment centerline and lay down. Clearly indicate all clearances with surrounding structure and equipment.

B. Submit Operation and Maintenance Manuals.

C. Submit manufacturer's certificates of compliance with the experience and quality assurance requirements indicated herein.

1. At the time of submitting shop drawings, submit the manufacturer's equipment warranty and certificate attesting that the manufacturer has examined the

Specifications and that the equipment to be provided will meet the performance criteria and conforms to the specification requirements.

D. Manufacturers Representative for Sales, Installation and Service Qualifications.

1.5 SPECIAL TOOLS AND SPARE PARTS

A. The manufacturer shall furnish one set of all special tools required to disassemble, service, repair, and adjust the Monorail trolley hoists and appurtenances.

B. Spare parts recommended by the manufacturer shall be provided.

PART 2 - **PRODUCTS**

2.1 GENERAL

A. The Monorail Trolley Hoist System shall be designed and furnished in accordance with ANSI - B30.16 and HST-2M Standard for overhead manual geared trolley hoists and as specified in this section.

B. The manual geared hoist and all appurtenances shall be provided and installed as a complete unit by the manufacturer or qualified Representative.

C. The Monorail beam size shall be as indicated on the drawings. The contractor shall coordinate the monorail beam location with the final locations of the equipment they service. Final location of monorail beam must be able to accommodate all hoist functions, movements and clearances needed to properly access the equipment. The trolley hoist system supplier shall verify compatibility of monorail hoist beam sizes and locations with the hoist equipment they are supplying.

2.2 CONDITIONS OF SERVICE

A. The Monorail Trolley Hoist shall consist of a manual close headroom geared - trolley hoist.

B. The Monorail Trolley Hoist shall meet the following requirements:

1. Location: Above the equipment hatch on the 2nd floor as indicated on the drawings.

    a. Use: equipment handling
    b. Ambient conditions: Indoors.
    c. Number Required: 1
    d. Type: Overhead, manual geared - Trolley Hoist.
    e. Capacity: 5 ton
    f. Hook Travel: As required to access equipment on 1st floor.

g. Span: As shown on drawings.

## 2.3 MONORAIL TROLLEY BEAM SYSTEM

A. The Monorail track beam shall conform to ANSI MH27 for manual powered hoist. The track beam sizes are as indicated on the drawings. Fabrication and installation of the track beam and all of its hangers, supports and braces shall be in accordance AWS D1.1 and AISC 14th edition. The track beams are sized to have a maximum allowable deflection that shall not exceed 1/600th of the unsupported span, with hoist at the rated load at any location. The stops shall interface with the trolley wheel tracks on both sides of the track web simultaneously and shall not interfere directly with the Trolley Wheels. The stops shall be constructed of ASTM A36 Plate and welded to the track beam in accordance with AWS D1.1 procedures. Track beam splices shall be continuously welded on all sides, ground and sanded smooth in accordance with AWS D1.1 Procedures. The track beam shall be shop cleaned and surface prepped for primer and painted in accordance with SSPC specifications and procedures and as noted in specification section 099100. The track beam finish color shall be safety yellow. Comply with SSPC specifications and procedures for field touch-up where required. The track beam shall clearly display the Trolley hoist maximum load capacity visible from a distance of 25’-0” or greater.

## 2.4 TROLLEY AND HOIST

A. The trolley hoist shall be the manually powered, hand geared trolley, monorail overhead, close headroom type incorporating the following features:

1. High-strength, electric-welded, heat-treated alloy steel single reeved link load chain.
2. Load chain guide and stripper.
3. Fully enclosed self-adjusting load brake of a friction-type screw and disc design.
4. Enclosed-gear train made from alloy-forged steel.
5. Precision, lifetime lubricated ball bearings.
6. End stop bumpers.
7. Wear resistant load sheave.
8. Thru-hardened track wheels, precision machine.
9. Adjustment mechanism for 4-inch to 8-inch beam flange with locking device.
10. Anti-tilt and Anti-drop devices.
11. Safety type latching hook assembly fracture resistant forged steel with hook nuts keyed to hook shanks by means of a set screw installed in a plane parallel to the longitude axis of the hook shank. Hook shall be capable of 360° rotation. All hook components shall be magnetic-particle inspected over the entire area.
12. Overload prevention device (capacity limiter) incorporating a slip clutch design.
13. Factory corrosion and wear resistant finish.

2.5 IDENTIFICATION

A. All component subassemblies shall be identified with steel nameplates and shall be marked with the following information.

1. Manufacturer and model number.
2. Date of manufacturer with all pertinent ratings and operation information.
3. Certification, stamp or label to applicable agency, codes and standards.

B. The rated load shall be plainly marked on the hoist and track beam at no less than 20' intervals on both sides. Markings shall be clearly legible from the operating floor.

C. Track beam shall have a safety yellow finish with black load capacity identification. Comply with OSHA requirements.

2.6 FACTORY FINISH

A. The hoist, track and appurtenances shall be thoroughly cleaned and shop painted. Refer to specification sections 051200 and 099100. Comply with SSPC Specifications and Procedures.

1. Color: Safety Yellow.

PART 3 - **EXECUTION**

3.1 INSTALLATION

A. Install equipment in accordance with approved Shop Drawings, manufacturers instructions, and in accordance with the Contract Documents. Comply with applicable Standards referenced in Part 1.3 "Quality Assurance". The Monorail Trolley Hoist manufacturer or qualified representative shall install or supervise and inspect the system installation.

B. Adjust test, and leave Monorail Trolley Hoist in proper operation condition.

C. Installation shall comply with the requirements of CMMA.

3.2 FIELD TESTING

A. Comply with the requirements of ANSI B30.11 and demonstrate operation of the trolley hoist as follows:

1. Operate Monorail Trolley Hoist from extreme points left and right and back again, three times unloaded, once loaded at 125% of rated capacity. Verify that the safety stops are not damaged in any manner and that limit of hook travel

conforms to requirements as stated in the specifications and shown in the Drawings.

2. Operate hoist from fully raised to fully lowered position and back again, three times unloaded, and once loaded at 125% of rated capacity.
3. With the hoist loaded to 125% of its rated capacity, position the trolley so that the load is at a point in the middle of the greatest unsupported span, and verify that the beam deflection is not greater than 0.00 166 inches per inch of span.

B. The Contractor shall furnish all weights necessary to test the Monorail Trolley Hoists.

C. All testing shall be performed by the Monorail Trolley Hoists manufacturer's certified testing agency in compliance with ASME B30.11. The Contractor shall not perform the tests.

D. Demonstrate access to the equipment to be handled has adequate lifting headroom.

3.3 FIELD FINISH

A. Field painting shall be performed at track beam field splices, at track beam connections to the structure and where any finish is damaged by handling, weather or other reasons. The field finished portion shall be primed and painted with sufficient finish coats to give a smooth, unmarred appearance, with primer and finish being the same type and color as originally used in the factory application, the manufacturer shall provide three (3) one gallon containers of both the factory primer and paint for this purpose. Comply with specifications and procedures of SSPC for field finishing.

3.4 SUPPLIER'S FIELD SERVICES

A. Furnish the services of a qualified field representative for the installation or supervision and inspection of the installation of the Monorail Trolley Hoists. Additionally the field representative shall provide a certified technician for not less than eight hours to instruct personnel in its operation and maintenance as specified under Division 1.

END OF SECTION 146400

# SECTION 210000 – BASIC MECHANICAL REQUIREMENTS – FIRE PROTECTION

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01Specification Sections, apply to this section and all other sections of Division 21.

### 1.2 SUMMARY

A. This Section includes the requirements for the following:

1. Codes, organizations, standards, and abbreviations
2. Fire protection design criteria and requirements
3. Designer/installer qualifications
4. Submittals
5. Site Visit
6. Outages
7. Cutting, welding and burning
8. Performance requirements
9. Material and equipment
10. Related work
11. Contract drawings.
12. Coordination
13. Demolition
14. Fire safe materials
15. UL requirements
16. Coordination drawings
17. Construction record documents
18. Operation and maintenance manuals
19. Fire stops and smoke seals
20. Guarantee / Warranty
21. Concrete pump base and grout
22. Equipment roughins
23. Cutting and patching
24. Installation requirements common to equipment specification sections
25. Excavation and back fill
26. Temporary service
27. Demonstrations
28. Final cleaning
29. Project punchout

### 1.3 CODES, ORGANIZATIONS, STANDARDS AND ABBRIVIATIONS

A. The following list of codes, organizations, standards and abbreviations are utilized within Division 21 Specification Sections and are provided as a reference.

B. Codes: All material and equipment provided and installed as part of these construction documents shall be in compliance with the latest edition of the following codes as adapted by the State of Maryland for the following:

1. IBC: International Building Code
2. IMC: International Mechanical Code
3. IECC: International Energy Conservation Code
4. Maryland State Fire Prevention Code
5. NEC: National Electrical Code
6. NFPA 1: Fire Code
7. NFPA 101: Life Safety Code
8. PHCC: National Standard Plumbing Code Illustrated

C. Organizations and Standards: Referenced organizations and standards are as follows:

1. ADA: American Disability Act
2. AEC: Architecture, Engineering and Construction
3. ANSI: American National Standards Institute
4. ASME: American Society of Mechanical Engineers
5. ASTM : American Society for Testing and Materials
6. ATA: American Translator Association
7. ATL: Aero Tec Laboratories
8. AWS: American Welding Society
9. AWWA: American Water Works Association
10. CS: Commercial Standard
11. CSA: Canadian Standards Association
12. FM: Facilities Management, Factory Mutual
13. MOSHA: Maryland Occupational Safety and Health Administration
14. MSSP: Manufacturers Standards Society of the Valve and Fittings Industry
15. NEMA: National Electrical Manufacturers Association
16. NFPA: National Fire Protection Association
17. NICET: National Institute for Certification in Engineering Technologies
18. NPS: National Pipe Standard
19. OSHA : Occupational Safety and Health Administration
20. SAE: Society of Automotive Engineers
21. UB: University of Baltimore
22. UL: Underwriters' Laboratories
23. UM: University of Maryland
24. UMB: University of Maryland, Baltimore
25. UMB-A/E: University of Maryland, Baltimore Architect/Engineer
26. UMB-FM: University of Maryland, Baltimore – Facilities Management

27. UMB-PM: University of Maryland, Baltimore Project Manager
28. UMBC: University of Maryland, Baltimore County

D. Abbreviations: Referenced abbreviations are as follows:

1. AC: Alternating Current
2. A/E: Architect/Engineer
3. AWG: American Wire Gauge
4. CAD: Computer Aided Design
5. CD-ROM: Compact Disk – Read Only Material
6. CM: Construction Manager
7. CMU: Concrete Masonry Unit
8. DOC: Document
9. FM: Facilities Management, Factory Mutual
10. Dwg: Drawing
11. EDPM: Ethylene Propylene Diene Terpolymer Rubber
12. EMT: Electrical Metallic Tubing
13. FM: Facilities Management
14. HOA: Hand Off Auto
15. HVAC: Heating Ventilation and Air Conditioning
16. ID: Inside Diameter
17. LED: Light Emitting Diode
18. LF: Linear Feet
19. MC: Metal Clad
20. MPa: Megapascal
21. NBR: Acrylonitrile-Butadiene, Buna-N, or Nitrile Rubber
22. NPS: National Pipe Standard
23. OD : Outside Diameter
24. Pdf: Portable Document Format
25. PSI: Pounds per Square Inch
26. PVC: Polyvinyl Chloride
27. RPM: Revolutions Per Minute

1.4 FIRE PROTECTION DESIGN CRITERIA AND REQUIREMENTS

A. Fire Protection Design Criteria: For Sprinkler System Design, Installation and Water Supply Requirements for all new construction and/or renovation projects on UMB's Campus use an occupancy classification of Ordinary Hazard – Group 1 as the basis of design unless otherwise directed by UMB.

B. Design and Installation: The sprinkler equipment manufacturer, designer and installer shall have been engaged in the manufacturer, design, installation and testing of sprinkler equipment for a minimum of not less than five (5) consecutive years..

C. System Modifications: All modifications to the existing sprinkler systems including piping, valves, alarms, sprinkler heads etc. shall be in accordance with NFPA - 13, latest edition, and as approved by the UMB Fire Marshal.

D. Floor Zones: Each floor/area shall be a separate zone from the balance of the building. Sprinkler system design shall ensure that 100 psi is available at the most remote fire hose connection in the system.

E. Sprinkler Heads: Sprinkler heads shall be provided as required by NFPA. Sprinkler head locations shall be coordinated with the architectural reflected ceiling plans.

F. New Construction: For New Construction Projects provide a Standpipe Riser for each Stairwell with a Fire Hose Connection on each level and at least one (1) Sprinkler Floor Zone Assembly per Floor. Where additional Sprinkler Floor Zone Assemblies may be required coordinate the number, and location of these assemblies with the UMB Fire Marshal and UMB Engineer.

G. Renovation Projects: For Campus Renovation Projects where portions of existing buildings are renovated, the number of Sprinkler Floor Zone Assemblies in the project area shall be the same as the rest of the building. Additional Floor Sprinkler Zones will not be allowed.

1. When the Existing Sprinkler Standpipe Riser and Sprinkler Floor Zone Assembly is within the project renovation area the existing Riser and Sprinkler Floor Zone Assembly shall be replaced with a New Riser, and Sprinkler Floor Zone Assembly. The new riser section shall be the same size as the existing riser between the floor slabs.

## 1.5 DESIGNER/INSTALLER QUALIFICATIONS

A. Installers Qualifications: The designer and installer of the fire protection system shall be a company who has been engaged in the sprinkler industry for a minimum of five (5) consecutive years and must be licensed by the Maryland State Fire Marshal’s Office. Equipment and installations shall comply with the year edition of NFPA 13 which is applicable within the State of Maryland at the time of contract execution. NICET certification is required for designers and installers.

## 1.6 SUBMITTALS

A. General: For general requirements see Architectural Specification Division 01 Section "Submittals".

B. In addition to the requirements identified in Architectural Specification Division 01 Section "Submittals" the fire protection contractor shall also comply with the following:

1. Submit drawings, hydraulic calculations, diagrams, schedules, samples and manufacturers catalogue cuts as one (1) complete set. The complete submittal set must be reviewed and approved by UMB Fire Marshal and Engineer before installation can take place. Partial Submittals will be rejected.

2. Detailed, dimensioned layout and working drawings/plans, together with descriptive specifications, schedules, and engineering data sheets for all manufactured material and equipment, shall be submitted for review. Drawings shall indicate the ceiling grid, lighting fixtures, air devices, etc. Any cost incurred for changes/corrections required by the UMB Fire Marshal shall be borne by the contractor.

3. Any deviations from the approved drawings shall be re-submitted to the UMB Fire Marshal's office for re-approval. The costs for corrections required by the UMB Fire Marshal shall be borne by the contractor.

C. Fire Protection Submittals: Provide submittals for all material, equipment and/or supports as specified in Division 21 and where indicated on the drawings and details. For additional material and data submission requirements see Division 21 Specification Sections. At a minimum the following submittals shall be provided as required by the project:

1. Sleeves, sleeve seals, and escutcheons.
2. Labels and signs.
3. Pipe, fittings and joints.
4. Valves and inspectors test assembly.
5. Supervisory and flow switches.
6. Cabinets.
7. Pressure gauges.
8. Hangers and supports.
9. Elevator key storage.
10. Sprinkler heads.
11. Inspectors test.
12. Wet pipe system and components.
13. Dry pipe system and components.
14. Pre-action system and components.
15. Hydraulic calculations.
16. Material and/or equipment samples when specified.
17. Coordinated drawings.

D. Submittal File Formats: File formats for each submittal shall be electronically as follows:

1. Product Data: "pdf" file format.
2. Shop Drawings: "pdf" and "dwg" file formats.
3. Coordinated Drawings: "pdf" or "dwg" file formats.

4. Schedules: “xl” file format.

E. Welder certificates signed by Contractor certifying that welders comply with requirements specified under the "Quality Assurance" Article.

1.7 SITE VISIT

A. Prior to preparing the bid, the fire protection subcontractor shall visit the site and become familiar with all existing conditions. Make all necessary investigations as to locations of utilities and all other matters which can affect the work. No additional compensation will be made to the contractor as a result of his failure to familiarize himself with the existing conditions under which the work must be performed.

1.8 OUTAGES

A. For all work requiring an outage, the fire protection subcontractor shall submit an outage request to the UMB Project Manager, using the UMB Standard Request for Outage Form which is available through the UMB Design and Construction Web Site at http://www.umaryland.edu/designandconstruction/, under the Documents Link. The existing fire protection system shall remain operational unless turned off by University personnel during the construction of the project.

B. Unless otherwise specified, outages of any services required for the performance of this contract and affecting areas other than the immediate work area shall be scheduled at least ten days (10) days in advance with the Office of Facilities Management. All such outages shall be performed on other than normal duty hours.

C. All fire protection outages which will interfere with the normal use of the building in any manner shall be done at such times as shall be mutually agreed upon by the contractor, the UMB Fire Marshal and the Office of Facilities Management.

D. The fire protection contractor shall include in his price the cost of all premium time required for outages and other work which interferes with the normal use of the building, which will be performed, in most cases, during other than normal work time and at the convenience of the University.

E. The operation of fire protection valves required to achieve an outage must be accomplished by University personnel only. Prospective subcontractors under this section are cautioned that the unauthorized operation of fire protection valves or other control devices by their personnel can result in extremely serious consequences for which the contractor will be held accountable.

1.9 CUTTING, WELDING, BURNING

A. Before the contractor and/or any sub-contractor commences any cutting, welding, burning, brazing (pipe sweating), the contractor shall obtain a hot work permit from Environmental Health and Safety at extension 1-410-706-3490.

B. The hot work permit copy shall remain on the job site at the hot work location until such work is completed at which time the permit shall be returned to Environmental Health and Safety.

1.10 PERFORMANCE REQUIREMENTS

A. Contract drawings are generally diagrammatic and do not indicate all offsets, fittings, transitions, access panels and other specialties required.

B. Furnish and install all items as may be required to fit the work to the conditions encountered.

C. Arrange piping, equipment and other work generally as shown on the contract drawings, and fire protection shop drawings providing proper clearances and access.

D. Where departures are proposed because of field conditions or other causes, prepare and submit detailed shop drawing submittal for approval in accordance with Submittals specified below.

E. The Architect may make reasonable changes in location of equipment piping and ductwork up to the time of rough-in or fabrication.

1.11 MATERIALS AND EQUIPMENT

A. The contract drawings and system performances have been designed on the basis of using the particular manufacturer's products specified or scheduled on the contract drawings.

B. Products of other manufacturer's listed in the specification shall be permitted provided as follows:

1. Products meet all of the requirements of the specifications.
2. Make, without additional cost to the Owner, all adjustments for deviations, such that the final installation is complete and functions as the basis of design product is intended.

C. Products with dimensions or other characteristics different from the basis of design product that render their use impractical or cause functional fit, access, or connection problems, shall not be acceptable.

D. Each item of equipment shall be capable of performing its function over an extended period of time with a minimum of attention and maintenance. All equipment and material

shall be constructed using new materials designed and built in accordance with the best practices of the industry. Each item of equipment shall be listed in the Underwriters Laboratories Fire Protection Equipment List or Factory Mutual Approval Guide. Each major item of equipment shall bear the manufacturer's name or trademark; serial number; U.L. or F.M. label; operating instructions and hydraulic characteristic conditions, etc., where applicable.

1.12 RELATED WORK

A. All work shall be properly coordinated with the design and installation of fire alarm equipment including but not limited to electrical (Wire and cable, raceway systems, junction boxes, emergency illumination, etc.), floor service or laboratory equipment, HVAC equipment, heating, ventilation, air conditioning and refrigeration piping, suppression systems (sprinkler, standpipe, gaseous suppression system tanks, etc.)

1.13 COORDINATION

A. Coordination: Coordinate fire protection systems, equipment, and materials installation with other building components.

B. Utilities: Coordinate connection of fire protection systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.

C. Chases: Arrange for chases, slots, and openings in building structure during progress of construction to allow for fire protection installations.

D. Sleeves: Coordinate the installation of required supporting devices and set sleeves in poured in place concrete and other structural components as they are constructed.

E. Sequencing: Sequence, coordinate, and integrate installations of fire protection material and equipment for efficient flow of the work. Give particular attention to large equipment requiring positioning prior to closing in the building.

F. Electrical Services; Coordinate connection of electrical services.

G. Access: Coordinate requirements for access panels and doors where fire protection items requiring access are concealed behind finished surfaces. Access panels and doors are specified in Architectural Specification Section "Access Doors."

H. Scheduling: Schedule and coordinate the delivery of material and equipment with other trades to avoid delivery conflicts.

1.14 DEMOLITION

A. Fire Protection Demolition: Cut, remove and legally dispose of selected Fire Protection piping, equipment, components, and materials as indicated, including but not limited to removal of Fire Protection piping, Fire Protection equipment, ductwork, plumbing fixtures and trim, and other Fire Protection items made obsolete by the new work.

1.15 FIRE SAFE MATERIALS

A. Unless otherwise indicated, materials shall conform to UL, NFPA or ASTM standards for fire safety with smoke and fire hazard rating not exceeding flame spread of twenty five (25) and smoke development of fifty (50).

1.16 UNDERWRITER'S LABORATORY (UL) REQUIREMENTS

A. All equipment containing electrical components and provided as part of the fire protection specifications shall bear the Underwriter's Laboratory (UL) label, as a complete packaged system.

1. Equipment not provided with a UL label shall be tested in the field, certified and provided with a UL label at the installer's expense.
2. Field testing shall be performed by a testing agency approved by the authority having jurisdiction.

1.17 CONSTRUCTION RECORD DOCUMENTS

A. The sprinkler contractor shall maintain a set of construction record documents during the construction period in accordance with Specification Division 01 Section "Contract Closeout."

1.18 OPERATION AND MAINTENANCE MANUALS

A. Prepare one (1) electronic maintenance manual file in "pdf" format in accordance with Specification Division 01 Section "Project Closeout."

**PART 2 – PRODUCTS**

2.1 LISTED MANUFACTURERS:

A. Listed Manufacturers: The listed manufacturers indicated in Part 2 of each specification section as the basis of design represents the minimum level of quality for materials and equipment that is acceptable to UMB. Unless otherwise indicated in each specification section, contractors may submit material and equipment by non listed manufacturers provided said submittals meet all of the requirements of these specifications. All submitted materials and equipment are subject to approval by the A/E and UMB.

B. Approved Equal Equipment Layouts: The equipment layouts and the related mechanical and electrical service connections, access space and supports indicated on the construction documents represent equipment provided by the specified basis of design manufacturer and model number. When the successful bidder chooses to provide "or approved equal" equipment by one (1) of the other listed manufacturers in the specifications, the bidder shall be responsible for providing all adjustments and modifications to the services necessary to make connections to the equipment, the bidder shall be responsible for installing the equipment such that all required clear access space is maintained, and the bidder shall be responsible for providing all adjustments and modifications to the equipment mounting and supports. All adjustments and modifications shall be provided by the bidder and appropriate subcontractors at no additional cost to the project.

2.2 COMBINATION MOTOR STARTERS AND CONTROLLERS – FIRE PROTECTION EQUIPMENT

A. Combination motor starters and/or controllers shall be provided for all motors serving HVAC equipment as follows:

1. Skid Mounted Equipment: Combination motor starters and/or controllers shall be provided by the equipment manufacturer as part of Division 21.
2. Non Skid Mounted Equipment: Combination motor starters and/or controllers shall be provided as part of Division 26.

**PART 3 - EXECUTION**

3.1 EXISTING FIRE PROTECTION SYSTEM

A. Building System: In no case shall any portion of a buildings fire protection system be taken out of service for more than four (4) hours in a twenty four (24) hour period without the written approval of UMB Fire Marshal.

B. Project Area: The parts of the fire protection system serving the project area can be placed out of service for periods of construction not exceeding four (4) hours. Coordination of the outage must be made with the project manager. When the construction is completed the fire protection system serving the project area shall be placed back in service. The operation of existing fire protection system valves to isolate the project area shall be accomplished by university personnel only. Submit an outage request for this work as specified.

C. Fire Watch: When a portion of the buildings fire protection system is taken out of service for a period of time exceeding ten (10) hours in a twenty-four (24) hour period, the sprinkler contractor shall comply with the following:

1. Eliminate potential ignition sources and limit the amount of fuel available to a fire.
2. Install a tag(s) to indicate the part of the system that has been removed from service. The tag(s) shall be installed on all components of the system that will be out of service.
3. Arrange for an approved fire watch.

3.2 EQUIPMENT ROUGH IN

A. Verify final locations for rough in's with field measurements and with the requirements of the actual equipment to be connected.

B. Refer to approved equipment submittals for actual rough in requirements.

3.3 MECHANICAL INSTALLATION - FIRE PROTECTION

A. Verify all dimensions by field measurements.

B. Where fire protection systems, materials and equipment are intended for overhead installation, and where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible. Notify UMB - PM prior to installation of sprinkler system components when headroom is less than 7'-6" and/or where existing system components will be below the new finished ceiling height. Notification shall be through the "RFI" process.

C. Install fire protection systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, identify the conflict and submit and "RFI" for each conflict to the Architect.

D. Install fire protection systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components.

E. Install fire protection equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.

F. Install fire protection systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

3.4 CUTTING AND PATCHING

A. General: Perform cutting and patching in accordance with Specification Division 01 Section "Cutting and Patching" In addition to the requirements specified in Specification Division 01, the following requirements apply:

1. Patch Materials: Patch finished surfaces and building components using new materials specified for the original installation and using experienced Installers. Installers' qualifications refer to the materials and methods required for the surface and building components being patched.

B. Cut, remove and legally dispose of selected fire protection equipment, components, and materials as indicated, including but not limited to removal of fire protection piping, sprinkler heads and trim made obsolete by the new work.

3.5 ERECTION OF METAL SUPPORTS AND ANCHORAGE

A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.

B. Field Welding: Comply with AWS D1.1 "Structural Welding Code--Steel."

3.6 DEMOLITION

A. Disconnect, demolish, and remove work specified as part of the fire protection specifications and as indicated. Remove pipes back to the active pipe to remain and cap.

B. Accessible Work: Remove indicated exposed pipe and ductwork in its entirety.

C. Removal: Remove indicated equipment from the Project site.

3.7 CLEANING AND FINISHES

A. Clean surfaces prior to application of insulation, adhesives, coating, and paint.

B. Provide factory applied finish where specified.

C. Protect all finishes, and restore all finishes to their original condition if damaged as a result of work installed as part of the mechanical specifications.

D. Remove all construction marking and writing from exposed equipment, piping and building surfaces.

3.8 LINTELS

A. Lintels shall be provided for openings in masonry, brick, concrete, etc. walls to accommodate work of this division.

1. Lintels shall be provided under this division when not being provided under other divisions. Lintels shall be approved by the Architect.

3.9 ELECTRICAL REQUIREMENTS

A. Unless otherwise indicated, furnish and install control and interlock wiring for the equipment furnished under this division. In general, power wiring and motor starting equipment will be provided as specified in the Division 26 Specifications.

1. Where the electrical requirements of the equipment furnished differ from the provisions made in the Division 26 Specifications, make the necessary allowances as part of the Mechanical Specifications.
2. Where no electrical provisions are included in the Division 26 Specifications, include all necessary electrical work as part of the Mechanical Specifications.

B. All electrical work performed as part of the mechanical specifications shall be provided in accordance with the Division 26 Specifications.

3.10 PROVISIONS FOR ACCESS

A. Insure adequate access is provided to all fire protection system components. The following list shall be used as a guide only:

1. Equipment.
2. Valves.
3. Drain points.

B. Access shall be adequate as determined by the A/E and UMB representatives.

C. Refer to contract drawings where access panels have been specifically located.

D. Where access is by means of lift out ceiling tiles or panels mark each access panel using small color coded or numbered tabs. Provide an index chart for identification. Place markers in corner of tile.

3.11 TEMPORARY SERVICE AND EQUIPMENT USE

A. Temporary Service: Do not use, fire protection systems for temporary services during construction unless authorized in writing by the A/E and the UMB Fire Marshal.

B. Equipment Use: Where such authorization is granted, temporary use of equipment shall not limit or otherwise affect warranties or guarantees of the work.

3.12 DEMONSTRATION AND INSTRUCTIONS

A. Demonstrate operation and maintenance of equipment and systems to Owner's personnel a minimum two (2) weeks prior to date of final inspection.

1. For equipment requiring seasonal operation, perform instructions for other seasons at the same time.
2. Training period shall be performed within one (1), two (2) week period.

B. Use operation and maintenance manuals and video as basis of instruction. Review contents of manual and video with personnel in detail to explain all aspects of operation and maintenance.

C. Demonstrate the following:

1. Start up.
2. Operation.
3. Control.
4. Servicing.
5. Maintenance.
6. Shutdown.

D. Provide at least forty (40) hours straight time instruction to the operating personnel.

1. This instruction period shall consist of not less than five (5) eight (8) hour days.
2. Time of instruction shall be designated by the Owner.
3. This instruction shall be in addition to instructional requirements of specific equipment specified elsewhere in the mechanical specifications.

3.13 WALL AND FLOOR PENETRATION

A. All penetrations of partitions, walls and floors by sprinkler piping and/or conduit installed under Division 21 shall be sealed and caulked. Provide U.L. listed fire stopping systems at penetrations through fire walls as specified in the Architectural Specifications.

3.14 CONSTRUCTION RECORD DRAWINGS

A. As the work progresses, the contractor shall record on one (1) set of prints, the installed locations, sizes, and depths of pipes, services, equipment, etc. which may differ from the approved contract drawings.

B. Upon completion of the fire protection system installations, the sprinkler contractor shall deliver to the construction manager one (1) complete set of marked-up blueprints of the fire protection system installation drawings along with the electronic "dwg" file indicating the "As Built" condition. The "As Built" condition shall include all construction revisions due to field conditions, "RFI's", "CB's", "ASI's" and/or owner requested revisions.

1. The mark-ups shall be legibly marked in red pencil to show all changes and departures of the installation as compared with the original design.
2. Refer to General Requirements of Specification Division 01 for additional requirements pertaining to Submittals and Record Drawings.
3. Unless otherwise directed by UMB the electronic file shall be submitted to the construction manager in Auto Cad Release 2016 or latest edition on a CD- Rom with All "Record Drawing" information neatly recorded thereon in red ink. The A/E shall verify that all "Record Drawing" information has been recorded on the electronic file. The electronic file and mark up set shall be turned over to UMB by the A/E.

C. At a minimum include the following installed conditions shall be recorded:

1. Location of all shut off valves, drain valves, and balancing valves with assigned valve tag numbers.
2. Show the location of concealed material and/or equipment requiring service.
3. Actual entering/leaving invert elevations for fire protection water service for the building.

3.15 FINAL CLEANING

A. General: General cleaning during construction is required by the General Conditions as indicated in Division 01 Specification Section "Temporary Facilities."

B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to the condition expected in a normal, commercial building cleaning and maintenance program. Comply with manufacturer's instructions.

C. Remove all mechanical clipping, wiring, nuts, bolts, etc. left on top of ceilings and ceiling tiles.

3.16 PROJECT PUNCH OUT

A. Architect/Engineer will perform punch out reviews and will provide the Contractor with a list of punch list items to be completed before contract close out. Each and every punch list item shall be initialed and dated by the Contractor when the work is complete. The Architect/Engineer will not perform any punch list verification until all items have been completed, initialed, dated and the list returned to the Architect/Engineer. If any items have been initialed as being completed by the Contractor and the Architect/Engineer determines that the work is not complete, the Architect/Engineer shall be reimbursed by the Contractor at his regular hourly rate for any and all items requiring revisiting of the site by the Architect/Engineer. Reimbursement shall be made by deducting the Architect/Engineer fee from the Contractor's final payment.

END OF SECTION 210000

# SECTION 211313 – FIRE PROTECTION SPRINKLER SYSTEMS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 21.

### 1.2 SUMMARY

A. This section includes requirements for furnishing, a complete fire protection and standpipe system and/or modifying an existing system including the following:

1. Pipe, fittings, and joints.
2. Valves and inspectors test assembly
3. Supervisory and flow switches.
4. Cabinets.
5. Pressure gauges.
6. Hangers.
7. Sprinkler heads.
8. Exterior fire department connection.
9. Fire department hose valves.
10. Wet fire protection system and accessories shop drawing.
11. Dry fire protection system and accessories shop drawing.
12. Pre-action fire protection system and accessories shop drawing.

### 1.3 ACTION SUBMITTALS

A. Product Data: For each specified product, include manufacturers cut sheets, dimensional data, performance data, installation instructions, wirings diagrams, power requirements, specified options, and warranty information.

B. Shop Drawings: For each fire protection system, include a complete fire protection system layout indicating the location, elevation, and sizes of the distribution piping, stand pipes, floor zone valves, related hangers, and sprinkler heads and include all required dimensional data. Also include the location of the water service entrance to the building, the fire pump, and components for a dry pipe or pre-action system and equipment power requirements. The system layout must be coordinated with the work of all other trades, light fixtures, air devices and ceiling systems.
   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

2. Sprinklers shall be referred to on drawings and shall be specifically identified by the listed manufacturer's style or series designation. Trade names and abbreviations are not permitted.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Field quality control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Product Data: Include a copy of the approved submittal for each product and material along with applicable maintenance data in the project operation and maintenance manual.

B. Operation and Maintenance Shop Drawing Data: Include a copy of the approved shop drawings and hydraulic calculations for each type of fire protection system in the operation and maintenance manual.

C. File format:

1. Product Data and Hydraulic Calculation Files: Submit product data and hydraulic calculation files in "pdf" format.
2. Shop Drawing Data: Submit file in "dwg" and "pdf" format.

1.6 PROJECT REQUIREMENTS

A. All modifications to the existing sprinkler systems including piping, valves, alarms, sprinkler locations, etc. shall be in accordance with NFPA - 13, latest edition, and as approved by the UMB Fire Marshall.

B. The sprinkler equipment manufacturer, designer and installer shall have been engaged in the manufacturing, design, installation and testing of sprinkler equipment for a minimum of not less than five consecutive years. NICET certification is requested.

C. Sprinklers shall be provided as required by NFPA. Sprinkler locations shall be coordinated with the architectural reflected ceiling plans.

D. Each floor/area shall be a separate zone from the balance of the building. Sprinkler system design shall ensure that 100 psi is available at the most remote fire hose connection in the system.

E. For New Construction Projects provide a Standpipe Riser for each Stairwell with a Fire Hose Connection on each level. Provide at least one Sprinkler Floor Zone Assembly per floor. Where additional Sprinkler Floor Zone Assemblies may be required, coordinate the

number and location of these assemblies with the UMB Fire Marshall and UMB Engineer.

1.7 QUALITY ASSURANCE

A. The contractor shall also, during the two (2) year guarantee period, be responsible for the proper adjustment on all systems, equipment, and apparatus, installed by him and do all the work necessary to ensure safe, efficient, and proper functioning of the systems and equipment at no cost to the University.

1.8 WARRANTY/GUARANTEE

A. See Division 21 Specification Section "Basic Mechanical Requirements – Fire Protection" for warranty and guarantee requirements.

**PART 2 - PRODUCTS**

2.1 GENERAL PRODUCT REQUIREMENTS

A. System Material and Design: The sprinkler system, standpipes, and all components and accessories shall be designed and selected for the intended use, in accordance with NFPA 13 and the requirements of this specification.

B. Pipe, Fittings and Joints: All Pipe, Fillings, and Joints used for Standpipe and Sprinkler Systems shall be as specified. Copper or Thin Wall (such as Allied XL, Schedule 10 Piping) or Plastic pipe shall not be used.

2.2 PIPE, FITTINGS, & JOINTS

A. All Grooved Couplings and Fittings shall be the product of one (1) manufacturer. Grooving Tools shall be of the same Manufacturer as the grooved components. The Contractor shall be responsible for replacing any Fitting, Coupling, Gasket or Device that was installed and is not included in the approved submittal. Pipe Material:

1. For Piping one half (1/2) inch to one and one half (1-1/2) inch use Schedule 40 Black Steel Pipe, 150 lb. ASTM A53 for Black Steel Pipe.
2. For Piping two (2) inches to eight (8) use Victaulic Rolled Grooved End Schedule 40 Black Steel Pipe, 150 lb. ANSI Class, ASTM F-1476. Grooved Ends shall be in accordance with dimensions specified by the Victaulic Company USA.
3. For Piping Larger than eight (8) inches use Victaulic Rolled Grooved End Schedule 30 Black Steel Pipe, 150 lb. ANSI Class, ASTM F-1476. Grooved Ends shall be in accordance with dimensions specified by the Victaulic Company USA.
4. All Piping subject to moisture and/or installed exposed to weather shall be Schedule 40 Hot Dipped Zinc Coated Galvanized Steel Pipe 150 lb. ASTM A 795 for Fire Protection Use. Galvanizing shall be in accordance with ASTM A – 153.

B. Fitting Material:

1. Fittings for Piping one half (1/2) inch to one and one half (1-1/2) inch shall be Malleable Iron Threaded Fittings for Elbows, Tees, Increasers, Reducers, 'Y' Fittings, and Thread-O-Lets conforming to ASME B 16.3, Class 150. Threads shall be per ANSI b.1.20.1.
2. Fittings for Piping two (2) inches to eight (8) inches shall be Ductile Iron Grooved End Fittings for Elbows, Tees, Increasers, Reducers, 'Y' Fittings, conforming to ASTM A - 395, Grade 65-45-15 and ASTM A - 536, Grade 65-45-12 grooved to accept Victaulic Firelock Couplings, Victaulic Short Pattern Fittings Style 001, 002, 003, 006, and 744 Flange Adapters. Fittings shall be short pattern, with flow equal to standard pattern fittings.
3. Fittings for Piping Larger than eight (8) inches shall be Ductile Iron Grooved End Fittings for Elbows, Tees, Increasers, Reducers, 'Y' Fittings, conforming to ASTM A - 395, Grade 65-45-15 and ASTM A - 536, Grade 65-45-12; Forged Steel conforming to ASTM A - 234; or factory fabricated from Carbon Steel Pipe conforming to ASTM A - 53; Grooved to accept Victaulic Standard Couplings and 741 Flange Adapters.
4. All Fittings subject to moisture and/or installed exposed to weather shall be Schedule 40 Hot Dipped Zinc Coated Galvanized Steel Pipe 150 lb. ASTM A 795 for Fire Protection Use. Galvanizing shall be in accordance with ASTM A – 153.

C. Joint Material:

1. Joints for Piping one half (1-1/2) inch to one and one half (1-1/2) inch shall be Threaded Joints conforming to American Standard for Pipe Threads ANSI B2.1.

2. Joints for piping two (2) inches to twelve (12) inches shall be Victaulic Installation Ready Style 009H and 107N Ductile Iron Couplings with offset angled bolt pads to accomplish rigidity and provide support in accordance with NFPA - 13. Couplings shall be fully installed at visual pad to pad offset contact. Couplings that require gapping of bolt pads or specific torque ratings for proper installation are not permitted. Gasket Material shall be Grade 'EHP' EPDM-HP or 'E' EPMD gasket material. All Joints shall be provided with ASTM A449 zinc electroplated Carbon Steel Nuts and Bolts. Housings shall be Cast Ductile Iron, conforming to ASTM A - 395, Grade 65-45-15, and ASTM A-536, Grade 65-45-12 Vic Flange Adapters: Vic Style 744, Class 150 or Style 743 Class 300 Ductile Iron, conforming to ASTM A 395, Grade 65-45-15, and ASTM A -536, Grade 65-45-12. Where Seismic Design requirements apply, use Victaulic Installation Ready Style 177 and Style 77 or 75 Couplings in accordance with the latest Victaulic Installation Instructions.

D. Fittings Not Allowed: Fittings that incorporate the use of a set screw or bolt tightened against a section of piping such as manufactured by J.B. Ward or Victaulic F.I.T. shall

not be used. Additional fittings, couplings, etc. that are not approved include, but are not limited to, the following:

1. Press Fit Piping Systems and Fittings
2. Plain End Piping Systems and Fittings
3. Snap on fittings. Example: Vic Style 925 Snap Let Outlet or Vic Style 791 Boltless Couplings
4. Strapless type fittings. Example: Vic Style 78 Snap Joint Coupling or couplings secured to the piping with U-Bolts
5. Tongue and Recess Style Couplings

E. Sprinkler Head Drops: In lieu of rigid pipe offsets or return bends for sprinkler drops, a flexible Stainless Steel Sprinkler Fitting System, as manufactured by Victaulic or approved equal, may be used to locate sprinklers in the ceiling tiles or in walls where indicated on the installation drawings. The system shall comply with the following:

1. Approvals: FM-1637 (Braided) or UL 2443. The sprinkler fitting system shall be listed or approved for installation in a suspended acoustical ceiling or hard ceiling system.
2. Mounting Bracket: Victaulic style AB mounting bracket shall be a one (1) piece tubular steel bracket and metal anchors suitable attachment to the ceiling support system. The bracket shall be anchored into the ceiling with a screw for a permanent installation. No wing nut style brackets will be allowed.
3. Hoses: Victaulic style AH flex hoses shall be a one (1) inch ID braided hose with a two (2) inch minimum bend radius and hydraulically calculated with a minimum of four (4) 90 degree bends. Hose length shall be limited up to forty eight (48) inches.
4. Labels: A tamper resistant label shall be installed on the bracket ends to prevent relocation of the heads.
5. Commissioning: A factory representative shall be on site to verify the system has been properly installed prior to final connections to the sprinkler heads.

2.3 VALVES

A. General: Valves shall be approved types and as specified in NFPA 13 and the U.L. All valves controlling fire protection water supplies shall be Outside Stem and Yoke (OS&Y). Butterfly valves shall be used only in areas where OS&Y Valves cannot be installed.

B. OS&Y Valves: OS&Y Valves shall be by Victaulic Series 771H Groove by Groove or Series 77iF Groove by Flange Pressure Rated up to 200 PSI, with ductile iron body (ASTM – 536), EPDM Body Gaskets, Steel Nuts and Bolts, and Cast Iron Hand Wheel (ASTM 126 – B) or approved equal by Grinnell, Viking Stockham, Muller, or Nibco.

C. Butterfly Valves: Butterfly Valves shall be Victaulic Series 705, Pressure Rated up to 300 PSI with Ductile Iron Body and Disc (ASTM – 536) EPDM pressure responsive seat, Teflon impregnated fiberglass with stainless steel backing Stem Bearings, EPDM O Ring, Carbon Steel Plated Tap Plug, Bracket and Weatherproof Actuator or approved equal by Grinnell, Viking, Stockham, Muller, or Nibco. The valve stem shall be offset from the disc centerline to provide complete 360 degree circumferential seating.

D. Trim and Drain Valves: Trim and drain valves include ball valves, globe valves and plug valves. Trim and Drain Valves installed as part of an automatic sprinkler system or fire protection standpipe shall have a minimum pressure rating of 175 PSI and be listed for use as part of a fire protection system by U.L.'s "Fire Protection Equipment Directory" or FM Global's "Approval Guide." Automatic (ball drip) drain valves shall comply with U.L. 1726. Ball drip valves shall be minimum NPS three-quarters (3/4) inch with threaded connections.

E. Check Valves: Provide check valves where required as follows:

1. Alarm Check Valve: An approved Alarm Check Valve (variable pressure type) with all appropriate trimmings shall be installed on the system side of the water supply control valve. Alarm Check Valves shall be by Victaulic Series 751, with a High Strength Ductile Iron Body (ASTM A-536 Grade 65-45-12), Aluminum Bronze Clapper, Stainless Steel Shaft – 17-4, EPDM Clapper Seal (ASTM D2000), Nitrile Seat O Rings, Stainless Steel Springs, and all necessary trim for a complete assembly, Pressure Rated up to 300 PSI or approved equal. The valves internal components shall be replaceable with the valve in the installed position. The top of the retard device or alarm line shall be fitted with an approved pressure switch Reliable Model 'G', Type 1, or equivalent. Conductors shall be provided under the electrical section to provide fire alarm and annunciation. Activation of the sprinkler system by one sprinkler or equivalent test shall cause the fire alarm system to activate and the appropriate lamp(s) to activate on the annunciator as "Main Water Flow".
2. Swing Check Valves: Swing-type Check valves shall comply with U.L. 312 rated up to 300 PSI with Cast Iron Body. Subject to compliance with requirements, provide Check Valves manufactured by Grinnell, Viking, Stockham, Muller, or Nibco.

F. Inspectors Test Connection: The Inspector's Test Device shall be Victaulic's Test Master II Alarm Test Module, Style 720, with screw threads.

G. Fire Department Hose Valves: Fire department hose valves shall be for Class I service only. Additional requirements shall be as follows for the project:

1. Hose valves shall be designed and located as required by NFPA 14. Hose valves shall be located within building stairway enclosures, with additional corridor

locations as required. The hose valves shall be installed at such an angle so that the fire hose is not obstructed or kinked when in use.

2. Fire department hose valves shall be two (2) inch to two and one half (2-1/2) inch with threads conforming to the National (American) Standard Fire Hose Coupling Screw Threads Standard, equipped with screw caps and pin lugs. Hose Valves shall be Potter Roemer Figure 4065, two and one half (2-1/2) inch Cast Brass Valve with a Red Handle, Female N.P.T. Inlet by Male hose thread outlet, polished brass finish, three hundred (300) pound rated or approved equal. Provide two and one half (2-1/2) inch to one and one half (1-1/2) inch reducers on each valve.
3. Approved two (2) way roof manifolds shall be provided where required by the appropriate code or standard. Roof manifolds will be minimum four (4) inch with two and one half (2-1/2) inch gated outlets with the interior control valve operable from the roof location. Suitable and accessible manual drains and automatic drip shall be provided.

H. Indicating Post/Wall Valves and Indicators: Provide indicating post wall valves and indicators where required as follows for the project:

1. The valve shall be an iron body unit approved by U.L. and designed for use with Wall or Post Indicators. The valves shall be non-rising stem. The valves shall be designed for either vertical or horizontal indicators.
2. The valves shall be Victaulic Series 773 Wall Post Indicator and/or Victaulic Series 774 Upright Post Indicator or approved equal by Grinnell, Viking Stockham, or Nibco.
3. The Post Indicator shall be supplied by the same manufacturer as the non-rising stem valve. The indicator shall have a handle for turning the valve on or off plus arranged to lock to the indicator body. The indicator shall be painted red.
4. The Wall Indicator shall be supplied by the same manufacturer as the non-rising stem valve.

## 2.4 SUPERVISORY SWITCHES AND WATER FLOW SWITCHES

A. Valve Supervisory Switch: The valve supervisory switch shall be System Sensor or Potter Model OSYSU-1, Outside Screw and Yoke Valve Supervisory Switch. Valve supervisory switches shall be electrically supervised and comply with U.L. 346. Components shall be single-pole, double-throw switch with normally closed contacts. Valve supervisory switches shall send a signal to building fire alarm system when the controlled valve is in other than a fully open position

B. Indicator-Post Supervisory Switches: Indicator-post supervisory switches shall be electrically supervised and comply with U.L. 346. Components shall be single-pole, double-throw switch with normally closed contacts. Post indicator supervisory switches shall send a signal to building fire alarm system when the controlled valve is in other than a fully open position.

C. Water Flow Switch: Water Flow Switches shall be System Sensor Model WFD or Model VSR-F by Potter Electric Co. or equivalent and shall be installed where specified by design requirements. Electrical conductors shall be provided under the Electrical Division to provide fire alarm and annunciation. Activation of the sprinkler system by one sprinkler or equivalent test shall initiate an alarm sequence at the Fire Alarm Control Panel and activate and the appropriate lamp(s) to activate on the Annunciator Panel.

2.5 CABINETS

A. Fire Protection Valve Cabinet: Provide and install where indicated on drawing Potter-Roemer Fig. No. 1810 recessed Fire Dept. Valve Cabinet with 20 gauge tubular steel door, and 18 gauge frame.

B. Sprinkler Cabinet: Provide a Metal Sprinkler Cabinet equipped with a supply of spare sprinklers. The spare sprinklers (not less than six of each type) shall correspond with each type of sprinkler and temperature rating that was installed in the project. Provide the necessary wrench(s) for each of the type sprinkler installed. The cabinet shall be a red baked enamel steel box by Potter Roamer Figure 6162, Victaulic or equal.

2.6 PRESSURE GAUGE

A. Pressure gauges shall comply with U.L. 393. Dials shall be three and one half (3-1/2) inches to four and one half (4-1/2) inches in diameter. Pressure gauge shall range from 0 to 300 PSI. Water system piping gauges shall include “WATER” or “AIR/WATER” label on dial face. Air system piping gauge shall include retard feature and “AIR” or “AIR/WATER” label on dial face.

2.7 HANGERS

A. All pipe hangers and hanger spacing shall be in strict accordance with NFPA 13.

2.8 SPRINKLERS HEADS

A. General: Sprinkler heads shall be listed by Underwriter's Laboratory and only new sprinkler heads shall be installed. Any sprinkler head that incurs damage, is painted or sprayed with any fire retardant material or other restrictive material before the system is accepted by the University, shall be replaced by the contractor at no cost to the Owner. Sprinkler heads shall be provided and installed in accordance with NFPA 13, and properly coordinated with other work. The correct sprinkler head type shall be used in every location.

B. Temperature Ratings: The correct temperature rating of every sprinkler head used shall be according to the maximum ceiling temperature rating and requirement according to the table in NFPA 13. All sprinkler heads (when required) shall have their frames colored coded with the special protective coatings applied by the manufacturer.

C. Sprinkler Head Type: Sprinklers shall be glass bulb type with hex shaped wrench boss integrally cast into the sprinkler body to reduce the risk of damage during installation. Wrenches shall be provided by the sprinkler manufacturer that directly engages the cast wrench boss.

1. Basis of Design shall be Sprinkler Heads manufactured by Viking and/or Tyco as indicated.
2. Other Acceptable Manufacturer shall be Sprinkler Heads manufactured by Victaulic where indicated.

D. Sprinkler Head Guards: Sprinkler heads that may be subject to damage due to their location under stairwells, or low hanging sprinklers in Corridors, Storage Rooms, Mechanical Equipment Rooms or under ducts shall be provided with Guards manufactured by the sprinkler company.

E. Spare Stock: A stock of spare sprinkler heads and appropriate wrench(s) shall be turned over to the University at the final acceptance testing. The stock of spare sprinklers shall be cabinet mounted and shall include all types and temperature ratings installed for this project. The number of spare sprinkler heads shall correspond to the requirements of NFPA 13 for each type and rating.

F. Coverage: Except for High Hazard Areas, Sprinkler heads shall be Standard Coverage type heads with a 'K' Factor of 5.6, unless modified by the following:

1. Pendent Sprinkler Heads: In suspended or plaster ceilings use Viking Horizon Quick Response Model 'VK 402' or Victaulic Model V27 Commercial Pendent 165ºF sprinkler heads and push on type escutcheon plate with a white finish to match adjacent ceiling and/or walls.
2. Side Wall Sprinkler Heads: Where sidewall heads are required in finished spaces use Viking Microfast Quick Response Model VK305 or Victaulic Model V27 Commercial 165ºF sidewall sprinkler heads and push on type escutcheon plate with a white finish to match adjacent ceiling and/or walls.
3. Exposed Sprinkler Heads: Where sprinkler piping is exposed use Viking Microfast Model 'VK300' or Victaulic Model V27 Quick Response 165ºF upright-type sprinkler heads.
4. Corrosive Area Sprinkler Heads: Where sprinkler heads are to be installed in corrosive areas use Viking Stainless Steel Micromatic Model 'N-2', VK130 upright-type or VK132 for pendent-type, 165ºF sprinkler heads.
5. Dry Pipe System Sprinkler Heads: Where dry sprinkler system protection is required use Viking Model Commercial Quick Response 165ºF Dry pendent or horizontal sidewall sprinkler heads, adjustable as required. Pendent sprinkler heads shall be Viking Type VK176, VK180 or VK172. or Victaulic Model V36 Sidewall sprinkler heads shall be Viking Type VK277, VK279 or VK275 with a

'K' Factor of eight (8) for lengths up to twenty (20) inches. Escutcheon plates shall be push on type with a white finish.

6. Concealed Sprinkler Heads: Where concealed sprinkler heads are required use Viking Mirage Model VK462 or Victaulic Model V38 or V39 Commercial Quick Response low profile concealed 165ºF pendent sprinkler heads and push on type escutcheon plate both with a white finish.

   a. Pendent Type: Use Viking Microfast Quick Response Model 'VK 302' Commercial Pendent 165ºF sprinkler heads and push on type escutcheon plate with a white polyester finish.
   b. Sidewall Type: Use Viking Microfast Quick Response Model 'VK 305' Commercial Sidewall 165ºF sprinkler heads and push on type escutcheon plate with a white polyester finish.
   c. Upright Type: Use Viking Microfast Quick Response Model 'VK 300' Commercial Upright 165ºF sprinkler heads and a white polyester finish.

7. Special Style Sprinkler Heads: Other special styles and types of sprinklers shall be specified as to style, temperature rating and protective coatings as the need arises.

## 2.9 EXTERIOR FIRE DEPARTMENT CONNECTION

A. Provide and install the required Exterior Fire Department Siamese Connection(s) and piping to the system. Each Exterior Fire Department Siamese Connection(s) shall be equipped with a ball drip. Piping shall be of the required size, but in no case shall be less than four (4) inches.

B. The Exterior Fire Department Siamese Connection(s) shall be chrome or brass finish flush type in a straightaway pattern and the required number of two and one half (2-1/2) inch inlets with threads conforming to the NFPA standard 1963" Fire Hose Connections".

C. Provide lockable caps for each Exterior Fire Department Standpipe Connection (s). Each Cap shall be an all Brass, two and one half (2-1/2) inch Male Plug with National Standard S/S Threads (3.068 TPI x 7.5 OD), and a S/S Front Cover with a key lock. Each cap shall be a FDC Cap, Number 3011 as manufactured by the Knox Company. Each key lock must be keyed for the Master Key used by the Baltimore City Fire Department Company and/or UMB. The contractor must coordinate the installation of these caps with the UMB Fire Marshall who has a Knox Key Wrench.

D. Low Point Drain: At the low point near each fire department connection, provide a 90 degree elbow with a drain connection to allow for localized system drainage to prevent freezing. Provide Victaulic FireLock Model 10-DR or approves equal.

## 2.10 FIRE DEPARTMENT HOSE VALVES

A. Fire department hose valves shall be for Class I service only.

B. Hose valves shall be designed and located as required by NFPA 14. Hose valves shall be located within building stairway enclosures, with additional corridor locations as required. The hose valves shall be installed at such an angle so that the fire hose is not obstructed or kinked when in use.

C. Approved two (2) way roof manifolds shall be provided where required by the appropriate code or standard. Roof manifolds will be minimum four (4) inch with two and one half (2-1/2) inch gated outlets with the interior control valve operable from the roof location. Suitable and accessible manual drains and automatic drip shall be provided.

D. Fire department hose valves shall be two (2) inch to two and one half (2-1/2) inch with threads conforming to the National (American) Standard Fire Hose Coupling Screw Threads Standard, equipped with screw caps and pin lugs. Hose Valves shall be Potter Roemer Figure 4065, two and one half (2-1/2) inch Cast Brass Valve with a Red Handle, Female N.P.T. Inlet by Male hose thread outlet, polished brass finish, three hundred (300) pound rated or approved equal. Provide two and one half (2-1/2) inch to one and one half (1-1/2) inch reducers on each valve.

2.11 DRY PIPE SPRINKLER SYSTEMS

A. Provide a Dry Pipe Valve Assembly, Victaulic Series 768NXT, Pressure Rated up to 300 PSI or approved equal with all the required trimmings.

B. All required Piping, Fittings, Joints, Valves etc. shall be as hereinbefore specified.

C. Dry Pipe Compressor System Components: Include the following:

1. Compressor:

a. Provide air cooled, single-state compressor with heavy balanced cast iron flywheel.
b. Pressure shall be up to 100 P.S.I.G. intermittent.
c. Lubrication shall be splash lubricated from dippers on connecting rods.
d. Air filters: pad type shall be built internally into cylinder head and are easily removed for cleaning or replacement.
e. Bearings shall be heavy-duty bronze journal bearings, extra large for long life.
f. Crank shafts shall be heavy-duty, machined and ground with integral counterweights.
g. Connecting Rods shall be aluminum alloy with extra large bearings.
h. Crankcases shall be cast iron with integral cast mounting feet. There is no gasket joint below oil level line. Units are equipped with duct tight breather valves.
i. Cylinders shall be iron alloy, precision bored and honed. Castings shall have deep cooling fins and shall be separate from crankcase to permit replacement.

j. Pistons shall be automotive type with two (2) compression and one (1) oil control ring. Hardened and ground piston pins.
k. Cylinder heads shall be cast iron with deep cooling fins.
l. Valves shall be replaceable disc type with hardened guides on single cylinder and high efficiency reed type, three (3) intake and three (3) discharge reeds per cylinder) on two (2) & four (4) cylinder units.
m. Oil level dip stick on two (2) & four (4) cylinder units. Visual on single cylinder unit.

2. Electric Motors: Provide NEMA type motors rated for continuous duty. Open, drip-proof motors with 1.25 service factor on fractional horsepower and 1.15 service factor on integral horsepower. Motors shall be dual voltage rated.

3. Air Receivers: Include the following:

a. Tank mounted unit shall be built to ASME specifications and National Board certified. Equipped with pressure gauge and ASME safety valve.
b. Provide an approved automatic air maintenance device for each system. Automatic Air Maintenance Device shall be Victaulic Series 757 Air Maintenance Trim Assembly with regulator, or approved equal, for each Dry Valve Assembly.

4. Bases: Base mounted unit shall be heavy-duty welded steel construction with necessary bolt holes for mounting.

5. Belt Guard: Provide totally enclosed steel belt guard providing maximum operating safety. Louvered to allow flow of cooling air over compressor pump. Easily unbolted front cover for belt replacement.

6. Drive: V-belt drive shall be designed for high load factor. Properly aligned for quiet continuous and efficient service.

7. Check Valve: Units shall be equipped with quiet operating check valve.

8. Aftercooler: Units shall have large diameter copper discharge line to deliver cooler air to air receiver.

9. Air Pressure Switch: Units shall be equipped with heavy-duty NEMA 1 adjustable pressure switch. Pressure switch shall be equipped with unloader valve to allow for a loadless start.

2.12 PRE-ACTION SYSTEMS: SUPERVISED SINGLE INTERLOCK TYPE WITH ELECTRIC ACTUATION

A. Provide all the components required by NFPA for a complete pre-action sprinkler system. The equipment shall include a deluge style automatic control valve with trim and all equipment required for electric release. All components must be UL and FM listed and approved by NFPA for use in a pre-action system.

B. The automatic control valve shall be a right angle style that is able to be reset without opening the valve. The release line shall be equipped with a hydraulic device preventing the valve from resetting until the system is manually reset. The valve shall be UL and FM listed and approved by NFPA for use in pre-action systems and compatible with the releasing equipment. The automatic valve shall be as manufactured by Victaulic, NXT Series 769 or approved equal. Include the following:

1. Pre-action valve clappers shall incorporate a latching mechanism that will not be affected by pressure changes in the water system.
2. In addition to automatic operation, arrange each valve for manual release at the valve.
3. Provide pressure gages and other appurtenances at the pre-action valves.
4. Provide a test detection device for each actuation circuit adjacent to each valve which the device controls as required by NFPA 13.

C. The release control panel shall be UL and FM listed and approved by NFPA for use in pre-action systems and compatible with the releasing solenoid. The detection system shall be compatible with the release control panel and listed for use in pre-action systems. The panel shall be programmable for crossed zoned detection from dip switch settings on the front of the mother board. The panel shall include supervised contacts for detection zones and signaling requirements per NFPA. Extra supervisory contacts shall be provided by a factory installed module with three alarm, two supervisory, and one trouble contact. The release control panel shall be a Model B-1, PDRD 2001, as manufactured by Victaulic or approved equal.

1. Battery & Charger System: Include the following:

a. Self contained batteries mounted within main control panel.
b. Rated for twenty four (24) hours of non-alarm monitoring plus five (5) minutes of alarm conditions.
c. Sized for 120% of Amp-Hour requirement per calculations.
d. Sealed lead acid type, maintenance free.
e. Minimum projected life of five (5) years.
f. Automatic operation upon loss of primary power.
g. Solid state automatic transfer switch to switch to battery power if the normal AC input voltage falls below 15% of nominal. The audible system trouble tone shall sound upon loss of AC input, and "LOSS OF AC POWER" message shall be displayed.
h. Automatic, variable rate battery charger: Include the following:

1) Capacity for 150% of the connected system load while maintaining batteries fully charged.
2) Capable of recharging batteries from fully discharged to fully charged in four (4) hours.
3) Fully supervised charger output.

D. The pre-action system shall be single interlocked. The operation of the detection system is required in order to open the valve; precharging the sprinkler pipe before a sprinkler operates. Air supervisory pressure shall monitor the integrity of the piping system. Loss of supervisory pressure shall indicate an alarm but the system control valve shall not open.

E. Pressure Switch: Provide switch with circuit opener or closer for the automatic transmittal of an alarm over the facility fire alarm system. Connect into the building fire alarm system. Alarm actuating device shall have mechanical diaphragm controlled retard device adjustable from ten (10) to sixty (60) seconds and shall instantly recycle.

F. Tank Mounted Air Compressor: Provide an approved, automatic type, electric motor driven air compressor with 38oF dew point air dryer, including pressure switch, air piping, and ten (10) gallon minimum capacity tank. Compressor shall have a minimum capacity capable of charging the complete sprinkler system to normal system air pressure within thirty (30) minutes while continuously delivering 38°F dew point air. Provide an approved automatic air maintenance device for each system. Automatic Air Maintenance Device shall be Victaulic Series 757 Air Maintenance Trim Assembly with regulator, or approved equal, for each Dry Valve Assembly.

G. Supervision: Pre-action sprinkler piping and pneumatic detection system and pre-action valve electric releases shall be supervised. A break in the piping or tubing systems resulting in loss of pneumatic pressure shall activate trouble alarm. Provide a silencing switch which transfers trouble signals to an indicating lamp; arrange so that correction of the trouble condition will automatically transfer the trouble signal from the indicating lamp back to the trouble alarm until the switch is restored to normal position.

H. Heat Detectors: Include the following:

1. Fixed Temperature Heat Detector.
2. Base with twist lock mounting.
3. Construction to prevent insect and dust entry.
4. Corrosion and vibration resistant.
5. Screw terminal wiring connections.
6. Fusible alloy thermal element.
7. Low profile, one and three eighth (1-3/8) inches from ceiling.
8. Element drops one (1) inch to indicate detector operation.
9. Replaceable elements without disassembling detector.
10. Temperature rating 135ºF, coordinated with sprinkler rating.

I. System Wiring: Include the following:

1. Solid copper conductors, #16 AWG minimum unless otherwise required by the system manufacturer.
2. PVC insulation, minimum 900C rated.
3. Single or multiconductor type.
4. UL Listed.
5. Compliant with NEC Art. 760.
6. Installed in EMT conduit, or type MC Cable.

## PART 3 - EXECUTION

### 3.1 GENERAL INSTALLATION REQUIREMENTS

A. Install all pipe, fittings, valves, controls, and hangers as required in accordance with NFPA 13.

B. The work under this contract shall be coordinated with that of all trades so that all work may be installed in the most direct and workmanlike manner and so that interference between piping, ducts, equipment, architectural and structural features will be avoided.

C. The sprinkler contractor shall install water flow alarms, valve supervisory devices, and any other sprinkler system equipment designed to be electrically interconnected into a fire alarm system but shall not inter- connect to the fire alarm system.

D. All electrical devices incorporating electrical apparatus installed by the sprinkler contractor as part of the sprinkler system shall be interconnected electrically under another section of these specifications.

E. Connection(s) shall be made to an approved water supply capable of delivering the necessary volume. The connection between the system piping and underground piping shall be made with a cast iron flanged piece, properly fastened.

### 3.2 PIPING

A. All Piping shall be run concealed in areas with suspended ceilings. Piping shall be installed and arranged to protect it from freezing and corrosion, and shall be pitched for drainage. Installation of all piping shall be in coordination with ducts, light fixtures, and any other work that may obstruct sprinklers.

B. All sprinkler piping shall be substantially supported from the building structure which must support the added load of water filled pipe plus a minimum of two hundred fifty (250) pounds applied at the point of hanging in accordance with NFPA 13.

C. All underground piping shall be rodded for the entire underground run. The rodding shall continue through the wall and into the building being protected and terminate at the interior system connection. Pillow blocks shall be installed at each change of piping direction and properly placed so as to prevent the lateral movement of the pipe.

D. Piping shall be installed and arranged so as to be protected from freezing, corrosion, and shall have the correct pitch for drainage. Installation of all piping shall be coordinated with the installation of ducts, light fixtures, ceiling grids, and all other work that may obstruct sprinklers.

E. All risers, including the alarm check valve, shall be equipped with drains sized as specified in NFPA 13. The alarm check valve drain (main drain) shall be piped to the outside of the building or to a Storm Water Sump with Pumps approved for the purpose by the Engineer and the UMB Fire Marshall. A supplementary drain of equal size shall then be provided for test purposes with free discharge, located at or above grade. An extra valve shall be installed in the line to the sump in order to close the line during tests.

3.3 PIPE JOINTS

A. Grooved Joints: Install in accordance with the manufacturer's latest published installation instructions. Pipe ends shall be clean and free from indentations, projections and roll marks in the area from pipe end to (and including) groove. Gasket shall be manufactured by the coupling manufacturer and verified as suitable for the intended service. A factory trained representative (direct employee) of the coupling manufacturer shall provide on-site training for contractor's field personnel in the use of grooving tools, application of groove, and product installation. The representative shall periodically visit the job site and review installation to ensure best practices in grooved joint installation are being followed. Contractor shall remove and replace any improperly installed products.

3.4 DRAINS AND TEST PIPING

A. Drains and test piping shall be furnished and installed so that all parts of the fire protection system may be drained and tested properly. Piping shall not be exposed to freezing (except approved dry pipe systems).

B. All interior sectional control valves, including riser control valves, shall be provided with auxiliary drainage so located as to drain that portion of the system controlled by the section al control valve. These sectional auxiliary drains shall be piped as indicated in paragraph 3.2.D.

C. Auxiliary drains shall be provided to properly drain all low points of the system when a change in direction prevents drainage through the main system.

D. All Sprinkler System drain piping, including main drain, each riser drain, all sectional auxiliary drains shall be piped individually or combined into one or more common drain

pipes which are piped to the Lower Level Mechanical Equipment Room and discharged into the sump pit. Where the drain piping cannot be piped to a Lower Level Mechanical Equipment Room the drain piping shall be combined into one or more sectional drains and piped to hose bibs located on the exterior of the building. Provide a sign at each hose bib that reads "SPRINKLER SYSTEM DRAIN". The location of these hose bibs and signs must be coordinated with the UMB A/E Staff and the UMB – FM.

3.5 SPRINKLER HEADS

A. Sprinkler heads shall be centered in finished ceiling tiles utilizing rigid pipe offsets, or return bends for the sprinkler drop or a flexible stainless steel sprinkler fitting system. Where rigid pipe offsets, return bends or flexible fitting systems are used for the sprinkler drop, the connection to the drop must be off of the top of the main or branch pipe.

B. In finished ceilings where more than two sprinklers are installed, the deflectors of all sprinklers shall be installed at the same elevation from the finished floor.

C. Do not install sprinklers that have been dropped, damaged, or show a visible loss of fluid. Never install sprinklers with cracked bulbs.

D. Sprinkler bulb protector shall be removed by hand after installation. Do not use tools or any other device(s) to remove the protector that could damage the bulb in any way.

3.6 SPRINKLER CABINET

A. The reserve sprinkler cabinet shall be surface mounted and installed on a wall adjacent to the main sprinkler controls for the fire pump, if provided. In buildings were there is no fire pump coordinate the location the new sprinkler cabinet with UMB A/E Staff and UMB - FM.

B. Provide a sign for the new sprinkler cabinet that reads "NEW SPRINKLER HEAD CABINET - DATE INSTASLLED - MO- DAY-YR".

3.7 INSPECTORS TEST CONNECTION

A. The inspectors test shall be installed in the top level of a sprinkler system and discharged into an approved drain discharge system.

B. In multi-storied buildings where water flow alarms are provided at each riser on each floor, or where more than one alarm device is provided at each riser on each floor, or where more than one alarm device is provided in one sprinkler system, an inspector's test device shall be provided for testing each alarm device.

3.8 VALVES

A. Provide at least one approved valve in each source of water supply except the fire department connection(s).

B. Provide approved indicating valves at the base of each major riser, unless there is only one riser.

C. Provide approved indicating valve on the supply side of the alarm check valve.

D. Provide approved indicating valves to control each floor or zones of sprinkler protection on each floor.

E. All valves controlling water supply for the sprinkler system shall be installed so that they may be readily accessible for use by emergency and maintenance personnel.

F. Drain and test valves shall be of approved types and in accordance with NFPA 13.

G. Drain and auxiliary valves shall be of an approved type and in accordance with NFPA 13 edition. Drain and auxiliary drain valves shall be either globe or angle valves as required and readily accessible for maintenance personnel.

H. Provide a supervised valve(s) for local control for each elevator machine room. Locate the valve outside of the room in an accessible location. Where local control valves are located above a ceiling provide a access door in hard ceilings and a sign mounted on the wall below the valve location. The sign should read “Local Sprinkler Control Valve”.

3.9 EXTERIOR FIRE DEPARTMENT CONNECTIONS

A. Each exterior fire department standpipe connection(s) shall be arranged to provide water to all parts of the system(s). On wet pipe systems with a single riser, the connection shall be made on the system side of the alarm check valve (on dry pipe systems, between the water supply control and dry pipe valve). On systems with two or more risers, the connection shall be made on the system side of the alarm check valve, but on the supply side of all riser shutoff valves.

B. The exterior fire department standpipe connection(s) shall be labeled "Automatic Sprinkler" or "Automatic Sprinkler and Standpipe" with raised letters at least one inch in size cast on the face by Allen, Badger-Powhattan, Elkhart or approved equal. The connection shall be located on a street side of the building, preferably on the front, not more than one hundred (100) feet from the nearest fire hydrant.

C. The connection shall be not less than two feet and not more than three feet six inches in elevation, measured from the ground level to the center of the inlets.

3.10 ALARM CHECK VALVE

A. All equipment shall be located and installed so that it is accessible for inspection, removal, and repair and shall be substantially supported.

B. The main drain from the alarm check valve shall be installed as specified.

C. The alarm check valve shall be provided with two standard gauges, one above the alarm check valve for system pressure, and one below for supply pressure. On vertical installations, the system pressure gauge shall be mounted at a higher elevation than the supply main gauge.

3.11 FIRE DEPARTMENT HOSE VALVES

A. Where the Fire Department Hose Valves are installed in a Hose Cabinet the valve(s) shall be positioned in the cabinet at an angle (300 to 450) with the cap positioned downward toward the floor.

3.12 HOLE SAW DISCS

A. If the contractor is required to make openings in the piping by means of a hole saw, the contractor shall remove the resultant discs (slug) and hang the discs adjacent to the hole cut. Failure by the contractor to do this will result in the contractor completely disassembling the sprinkler system to satisfy the engineer that the discs is not in the system piping.

3.13 DUST, SOIL, DEBRIS

A. The contractor shall take such steps as necessary to protect the surface and contents of rooms in which work is in operation, from damage from his/her operation. The room contents shall be either moved out of the way or covered with waterproof coverings while work is in progress. The contractor shall remove and replace ceilings and protect them against dirt and damage.

B. Particular care shall be exercised to prevent staining damage from cutting oils used in the cutting and threading of pipe.

C. Suitable non-permeable drop cloths shall be used under all cutting and threading machines.

D. The contractor will be held responsible and accountable for any damage resulting from his/her operation.

3.14 CUTTING AND PATCHING

A. The cutting of walls and floors for passage and accommodation of new piping, the closing of openings and removal of all debris caused by the work under this contract shall be performed by and at the expense of the contractor.

B. Patching shall be uniform in appearance and shall match the surrounding surfaces. New openings in existing C.M.U. floors shall be drilled with diamond core drills.

C. Building surfaces cut, damaged or removed in the performance of work under this contract shall be repaired as close to their original condition.

3.15 INSTALLATION, TESTS, AND ACCEPTANCE

A. Installation, testing, and final acceptance shall be in accordance with all applicable codes, and authorities having jurisdiction.

B. For pressure test requirements see Division 21 Specification Section “Leak Test Fire Protection Piping Systems”.

3.16 DOCUMENTATION

A. The following documentation shall be furnished to the University by the contractor at the conclusion of the final acceptance test:

1. Operating and maintenance instructions of controllers, alarm valves, etc. as required by NFPA 13.
2. The spare sprinklers hereinbefore specified and wrench(s).
3. A copy of NFPA 25 Water-Based Fire protection Systems.

3.17 DEMONSTRATION OF SPRINKLER AND STANDPIPE SYSTEMS

A. Demonstrate equipment, specialties, and accessories. Review operating and maintenance information.

B. Schedule demonstration with at least seven (7) days advance notice.

3.18 DRY PIPE SYSTEMS

A. The installation for dry pipe sprinkler systems shall comply with the foregoing specifications, except where specifically modified in NFPA 13 for dry pipe sprinkler systems.

B. The connection from the fire department siamese shall be made from the system side of the main control valve and on the supply side of the dry pipe alarm check valve.

C. Auxiliary drains shall consist of a one half (1/2) inch valve with nipple and cap for under five (5) gallons capacity of trapped and two (2), one (1) inch valves with two (2) inch by

twelve (12) inch nipple or equivalent for over five (5) gallons. Tie in drains shall be minimum one (1) inch.

D. Installation, location, and protection of dry pipe sprinkler systems shall be in accordance with NFPA 13. The required continuous air compressor and heater (s) shall be connected to an emergency electrical power source.

E. Sufficient OS&Y Valves and Check Valves shall be provided so that either pump can be isolated for inspection and service.

F. An approved dry pipe valve with all the trimmings shall be installed on the system side of the main water valve. All equipment shall be located and installed so that it is accessible for inspection, removal and repair and shall be substantially supported.

3.19 PRE-ACTION SYSTEM – FIELD WIRING

A. Under this Section, provide all wiring of heat detectors ad pre-action control in accordance with NEC, NFPA, and Electrical Specifications, and as herein specified.

B. Pre-action system wiring shall include:

1. Initiating device circuits (IDC).
2. Miscellaneous control wiring.

C. Installation of fire alarm wiring:

1. Install all wiring in conduit.
2. Identify conduit and boxes with red paint at regular intervals. (all boxes and every 8-10 LF).
3. MC Cable may be used in lieu of EMT.
4. Do not mix fire alarm wiring with wiring of any other system.
5. Use distinctive color coding for insulation.

a. Distinct from all power wiring colors.
b. Different colors for IDC, NAC and SLC wiring.

D. System Supervision:

1. NFPA Class B, (Style B).
2. Wiring supervised for open circuits and grounds.
3. Open or ground shall cause Trouble signal.
4. System shall be capable of alarm signal receipt during a single ground fault condition.
5. Each alarm and trouble LED shall be supervised.

END OF SECTION 211313

# SECTION 220000 – BASIC MECHANICAL REQUIREMENTS – PLUMBING

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 22.

### 1.2 SUMMARY

A. This Section includes the requirements for the following: :

1. Codes, organizations, standards, and abbreviations
2. Submittals
3. Site Visit
4. Outages
5. Variances
6. Cutting, welding and burning
7. Performance requirements
8. Material and equipment
9. Related work
10. Contract drawings
11. Coordination
12. Demolition
13. Fire safe materials
14. UL requirements
15. Construction record documents.
16. Operation and maintenance manuals
17. Fire stops and smoke seals
18. Guarantee / Warranty
19. Pipe and supports
20. Equipment roughins
21. Cutting and patching
22. Installation requirements common to equipment specification sections
23. Excavation and back fill
24. Temporary service
25. Demonstrations
26. Final cleaning

### 1.3 CODES, ORGANIZATIONS, STANDARDS AND ABBRIVIATIONS

A. The following list of codes, organizations, standards and abbreviations are utilized within Division 22 Specification Sections and are provided as a reference.

B. Codes: All material and equipment provided and installed as part of these construction documents shall be in compliance with the latest edition of the following codes as adapted by the State of Maryland for the following codes:

1. IBC: International Building Code
2. IMC: International Mechanical Code
3. IECC: International Energy Conservation Code
4. NEC: National Electrical Code
5. NFPA: National Fire Protection Association
6. PHCC: National Standard Plumbing Code Illustrated

C. Organizations and Standards: The list of organizations and standards are as follows:

1. ADA: American National Standards Institute
2. AGA: American Gas Association
3. ANSI: American National Standards Institute
4. ASHRAE: American Society of Heating Refrigeration and Air Conditioning Engineers
5. ASME: American Society of Mechanical Engineers
6. ASSE: American Society of Safety Engineers
7. ASTM: American Society for Testing and Materials
8. AWS: American Welding Society
9. AWWA: American Water Works Association
10. CDA: Copper Development Association Inc.
11. CFR; Code of Federal Regulations
12. CGA: Compressed Gas Association
13. CISPI: Cast Iron Soil Pipe Institute
14. CS: Commercial Standard
15. CSA: Canadian Standards Association
16. EJMA: Expansion Joint Manufacturers Association
17. EPA: Environmental Protection Agency
18. FDA: Food and Drug Administration
19. IAPMO: International Association of Plumbing and Mechanical Officials
20. IBC: International Building Code
21. IBR: Institute of Boiler and Radiator Manufacturers
22. ICC: International Code Council
23. IEEE: Institute of Electrical and Electronics Engineers
24. LED: Light Emitting Diode
25. MFMA: Metal Framing Manufacturers Association
26. MOSHA: Maryland Occupational Safety and Health Administration
27. MSS: Manufacturers Standardization Society
28. MSS SP: Manufacturers Standardization Society Standard Practice
29. NEMA: National Electrical Manufacturers Association
30. NEMA MG: National Electrical Manufacturers Association Motors & Generators
31. NFPA: National Fire Protection Association
32. NICET: National Institute for Certification in Engineering Technologies

33. NSF: National Sanitation Foundation
34. NRTL: Nationally Recognized Testing Laboratory
35. OSHA: Occupational Safety and Health Administration
36. OSHPD: Office of Statewide Health Planning and Development
37. PDI: Plumbing and Drainage Institute
38. SEI: Software Engineering Institute
39. SSPC: Society for Protective Coatings
40. UB: University of Baltimore
41. UL: Underwriters' Laboratories
42. UM: University of Maryland
43. UMB: University of Maryland, Baltimore
44. UMB-A/E: University of Maryland, Baltimore – Architect/Engineer
45. UMB-FM: University of Maryland, Baltimore – Facilities Management
46. UMB-PM: University of Maryland, Baltimore – Project Manager
47. UMBC: University of Maryland, Baltimore County

D. Abbreviations: The list of abbreviations are as follows:

1. AEC: Architecture, Engineering and Construction
2. ASJ: All Service Jacket
3. AWF: All Weather Finish
4. AWG: American Wire Gauge
5. CAD: Computer Aided Design
6. CD-ROM: Compact Disk – Read Only Material
7. CM: Construction Manager
8. CWP: Cold Working Pressure
9. ºC: Degree Celsius
10. ºF: Degree Fahrenheit
11. Dwg: Drawing
12. DOC: Document
13. Dwg: Drawing
14. EPDM: Ethylene Propylene Diene Terpolymer Rubber
15. FNPT: Female National Pipe Thread
16. FSK: Foil-Scrim-Kraft
17. FT: Foot, Feet
18. GC: Glass Cloth
19. GPH: Gallons per Hour
20. HCFC: Hydrochlorofluorocarbons
21. HNBR: Hydrogenated Nitrile Butadiene Rubber
22. HP: Horse Power
23. HVAC: Heating Ventilation and Air Conditioning
24. Hz: Hertz
25. ID: Inside Diameter
26. IEQ: Indoor Environmental Quality
27. IN: Inches
28. Lb/ft: Pound-Foot

29. LED: Light Emitting Diode
30. LF: Linear Feet
31. LLDPE: Linear Low Density Polyethylene Resins
32. MAX: Maximum
33. MER: Mechanical Equipment Room
34. MIN: Minimum
35. N/A: Not Applicable
36. NBR: Acrylonitrile-Butadiene, Buna-N, or Nitrile Rubber
37. NOM: Nominal
38. NPS: Nominal Pipe Size
39. NPT: National Pipe Thread
40. NRS: Nonrising Stem
41. OD: Outside Diameter
42. OS&Y: Outside Screw and Yoke
43. Pdf: Portable Document Format
44. PE: Polyethylene
45. PSI: Pounds per Square Inch
46. PSIG: Pounds per Square Inch Gage
47. PVC: Polyvinyl Chloride
48. RS: Rising Stem
49. UV: Ultraviolet
50. V: Volt
51. VAC: Vacuum
52. VOC: Volatile organic compounds

## 1.4 SUBMITTALS

A. General: For general requirements see Architectural Specification Division 01 Section "Submittals".

B. Provide submittals for all material, equipment and/or supports as specified in Division 22 and where indicated on the drawings and details. For material and product data submission requirements see Division 22 Specification Sections. At a minimum the following submittals shall be provided as required by the project:

1. Pipe, fittings and accessories for each system.
2. Valves, strainers and unions for each system.
3. Insulation.
4. Hangers and supports.
5. Plumbing fixtures and trim.
6. Identification labels and tags.
7. Floor drains.
8. Hot water heating equipment.
9. Trap priming system.
10. Backflow preventers.
11. Pipe and supports.

C. Submittal File Format: File formats for each submittal shall be electronically as follows:

1. Product Data: “pdf” file format.
2. Shop Drawings: “pdf” file format.
3. Coordinated Drawings: “pdf” or “dwg” file formats.
4. Schedules: “xl” file format.

## 1.5 SITE VISIT

A. Prior to preparing the bid, the mechanical plumbing subcontractor shall visit the site and become familiar with all existing conditions. Make all necessary investigations as to locations of utilities and all other matters which can affect the work. No additional compensation will be made to the contractor as a result of his failure to familiarize himself with the existing conditions under which the work must be performed.

## 1.6 OUTAGES

A. For all work requiring an outage, the mechanical/plumbing contractor shall submit an outage request to the UMB Project Manager, using the UMB Standard Request for Outage Form which is available through the UMB Design and Construction Web Site at http://www.umaryland.edu/designandconstruction/, under the Documents Link. The existing plumbing system shall remain operational unless turned off by University personnel during the construction of the project.

B. Unless otherwise specified, outages of any services required for the performance of this contract and affecting areas other than the immediate work area shall be scheduled at least ten days (10) days in advance with the Office of Facilities Management. All such outages shall be performed on other than normal duty hours.

C. All plumbing outages which will interfere with the normal use of the building in any manner shall be done at such times as shall be mutually agreed upon by the contractor and the Office of Facilities Management.

D. The plumbing contractor shall include in his price the cost of all premium time required for outages and other work which interferes with the normal use of the building, which will be performed, in most cases, during other than normal work time and at the convenience of the University.

E. The operation of plumbing valves or switches; required to achieve an outage must be accomplished by University personnel only. Prospective subcontractors under this section are cautioned that the unauthorized operation of plumbing valves, power switches, or other control devices by their personnel can result in extremely serious consequences for which the contractor will be held accountable.

1.7 VARIANCES

A. Where variances occur between the drawings and specifications or within either document itself, the item or arrangement of better quality, greater quantity or higher cost shall be included in the contract price. The Engineer shall decide on the item and manner in which the work shall be provided.

1.8 CUTTING, WELDING, BURNING

A. Before the contractor and/or any sub-contractor commences any cutting, welding, burning, brazing (pipe sweating), the contractor shall obtain a hot work permit from Environmental Health and Safety at extension 1-410-706-7055.

B. The hot work permit copy shall remain on the job site at the hot work location until such work is completed at which time the permit shall be returned to Environmental Health and Safety.

1.9 PERFORMANCE REQUIREMENTS

A. Contract drawings are generally diagrammatic and do not indicate all offsets, fittings, transitions, access panels and other specialties required. Furnish and install all items as may be required to fit the work to the conditions encountered.

B. Arrange plumbing piping, equipment and other work generally as shown on the contract drawings, providing proper clearances and access.

C. Where departures are proposed because of field conditions or other causes, prepare and submit detailed shop drawing submittal for approval in accordance with Submittals specified below.

D. The Architect may make reasonable changes in location of equipment piping and ductwork up to the time of rough-in or fabrication.

1.10 MATERIALS AND EQUIPMENT

A. The contract drawings and system performances have been designed on the basis of using the particular manufacturer’s products specified or scheduled on the contract drawings.

B. Products of other manufacturer’s listed in the specification shall be permitted provided as follows:

1. Products meet all of the requirements of the specifications.
2. Make, without additional cost to the Owner, all adjustments for deviations, such that the final installation is complete and functions as the basis of design product is intended.

C. Products with dimensions or other characteristics different from the basis of design product that render their use impractical or cause functional fit, access, or connection problems, shall not be acceptable.

1.11 COORDINATION, SEQUENCING AND SCHEDULING

A. Coordination: Coordinate plumbing systems, equipment, and materials installation with other building components.
B. Utilities: Coordinate connection of plumbing systems with exterior underground services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.

C. Chases: Arrange for chases, slots, and openings in building structure during progress of construction to allow for mechanical installations.

D. Sleeves: Coordinate the installation of required supporting devices and set sleeves in poured in place concrete and other structural components as they are constructed.

E. Sequencing: Sequence, coordinate, and integrate installations of plumbing material and equipment for efficient flow of the work. Give particular attention to large equipment requiring positioning prior to closing in the building.

F. Electrical Services: Coordinate connection of electrical services.

G. Access: Coordinate requirements for access panels and doors where mechanical items requiring access are concealed behind finished surfaces. Access panels and doors are specified in Architectural Specification Section "Access Doors."

H. Scheduling: Schedule and coordinate the delivery of material and equipment with other trades to avoid delivery conflicts.

1.12 DEMOLITION

A. Plumbing Demolition: Not applicable.

1.13 FIRE SAFE MATERIALS

A. Unless otherwise indicated, materials shall conform to UL, NFPA or ASTM standards for fire safety with smoke and fire hazard rating not exceeding flame spread of twenty five (25) and smoke development of fifty (50).

1.14 UNDERWRITER’S LABORATORY (UL) REQUIREMENTS

A. All equipment containing electrical components and provided as part of the mechanical specifications shall bear the Underwriter's Laboratory (UL) label, as a complete packaged system.

1. Equipment not provided with a UL label shall be tested in the field, certified and provided with a UL label at the installer's expense.
2. Field testing shall be performed by a testing agency approved by the authority having jurisdiction.

1.15 CONSTRUCTION RECORD DOCUMENTS

A. The mechanical/plumbing contractor shall maintain a set of construction record documents during the construction period in accordance with Specification Division 01 Section "Project Closeout".

1.16 OPERATION AND MAINTENANCE MANUALS

A. Prepare one (1) electronic maintenance manual file in "pdf" format in accordance with Specification Division 01 Section "Project Closeout."

1.17 FIRE STOPS & SMOKE SEALS

A. Fire stops and smoke seals shall be provided by one (1) manufacturer for all trades. See Architectural Specification Division 07 for requirements.

1.18 WARRANTY/GUARANTEE

A. All materials, equipment, etc. provided by the general contractor and/or his subcontractors shall be warranted and guaranteed to be free from defects in workmanship and materials for a period of two (2) years from the date of substantial completion and acceptance of work by UMB. Any defects in workmanship, materials, or performance which appear within the guarantee period shall be corrected by the contractor without cost to the owner, within a reasonable time, to be specified by UMB. In default thereof, owner may have such work done and charge the cost of same to the contractor. In addition to the above statement the Warranty/Guarantee Period shall include also all labor cost related to all warranty work. For compressorized equipment include an additional three (3) year Warranty/Guarantee Period.

**PART 2 - PRODUCTS**

2.1 LISTED MANUFACTURERS:

A. Listed Manufacturers: The listed manufacturers indicated in Part 2 of each specification section as the basis of design represents the minimum level of quality for materials and equipment that is acceptable to UMB. Unless otherwise indicated in each specification

section, contractors may submit material and equipment by non listed manufacturers provided said submittals meet all of the requirements of these specifications. All submitted materials and equipment are subject to approval by the A/E and UMB.

B. Approved Equal Equipment Layouts: The equipment layouts and the related mechanical and electrical service connections, access space and supports indicated on the construction documents represent equipment provided by the specified basis of design manufacturer and model number. When the successful bidder chooses to provide "or approved equal" equipment by one (1) of the other listed manufacturers in the specifications, the bidder shall be responsible for providing all adjustments and modifications to the services necessary to make connections to the equipment, the bidder shall be responsible for installing the equipment such that all required clear access space is maintained, and the bidder shall be responsible for providing all adjustments and modifications to the equipment mounting and supports. All adjustments and modifications shall be provided by the bidder and appropriate subcontractors at no additional cost to the project.

## PART 3 - EXECUTION

### 3.1 EQUIPMENT ROUGH IN AND FINAL CONNECTIONS

A. Locations: Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

B. Rough in Requirements: Refer to equipment specifications included in the architectural, mechanical, and electrical specifications for equipment rough in requirements. Provide final connections for each piece of equipment.

C. Owner Furnished Equipment: Refer to owner supplies equipment specifications and/or cut sheets for equipment rough in requirements. Provide final connections for each piece of owner supplied equipment.

### 3.2 MECHANICAL INSTALLATIONS - PLUMBING

A. Verify all dimensions by field measurements.

B. Where plumbing systems, materials and equipment are intended for overhead installation, and where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible. Notify UMB - PM prior to installation of plumbing system components when headroom is less than 7'-6" and/or where existing system components will be below the new finished ceiling height. Notification shall be through the "RFI" process.

C. Install plumbing systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the

Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, identify the conflict and submit and "RFI" for each conflict to the Architect.

D. Install plumbing systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components.

E. Install plumbing equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.

F. Install access panel or doors where material and/or equipment requiring service will be concealed behind finished surfaces. Access panels and doors are specified in the architectural specifications.

G. Install plumbing systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

H. The contractor shall confirm that all pressure vessels are installed in full compliance with the requirements of the Sate Inspector's Office for Boilers and Pressure Vessels. Refer to "Closeout Procedures" in this Section for additional requirements.

3.3 EXISTING PLUMBING SYSTEMS

A. Building: In no case shall the buildings plumbing systems be placed out of service for any period of time unless it is in an emergency condition as directed by the University.

Project Area: The parts of the plumbing systems serving the project area can be placed out of service for the construction period. When the construction is completed the plumbing system serving the project area shall be placed back in service.

3.4 CUTTING AND PATCHING

A. General: Perform cutting and patching in accordance with Division 01 Specification Section "Cutting and Patching" In addition to the requirements specified in Specification Division 01, the following requirements apply:

1. Patch Materials: Patch finished surfaces and building components using new materials specified for the original installation and using experienced Installers. Installers' qualifications refer to the materials and methods required for the surface and building components being patched.

B. Cut, remove and legally dispose of selected mechanical equipment, components, and materials as indicated, including but not limited to removal of mechanical piping, heating units, ductwork, plumbing fixtures and trim, and other mechanical items made obsolete by the new work.

3.5 PAINTING

A. Refer to Architectural Specification Section "Painting" for field painting requirements.

B. CONCRETE BASES

Construct concrete equipment bases of dimensions indicated, but not less than four (4) inches (100 mm) larger than supported unit in both directions. Follow supported equipment manufacturer's setting templates for anchor bolt and tie locations. Use 3,000 psi (20.70MPa), twenty eight (28) day compressive strength concrete and reinforcement bars as specified in the architectural specifications.

3.6 ERECTION OF METAL SUPPORTS AND ANCHORAGE

A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.

B. Field Welding: Comply with AWS D1.1 "Structural Welding Code--Steel."

3.7 DEMOLITION

A. Disconnect, demolish, and remove work specified as part of the plumbing specifications and as indicated. Remove pipes back to the active pipe to remain and cap.

B. Where pipe, insulation, or equipment to remain is damaged or disturbed, remove damaged portions and install new products of equal capacity and quality.

C. Accessible Work: Remove indicated exposed pipe and ductwork in its entirety.

D. Abandoned Work: Cut and remove buried pipe abandoned in place, two (2) inches (50 mm) beyond the face of adjacent construction. Cap and patch surface to match existing finish.

E. Removal: Remove indicated equipment from the Project site.

C. Temporary Disconnection: Remove, store, clean, reinstall, reconnect, and make operational equipment indicated for relocation.

3.8 PENETRATION OF WATERPROOF CONSTRUCTION

A. Coordinate the work to minimize penetration of waterproof construction, including roofs, exterior walls and interior waterproof construction.

B. Furnish and install drains, curbs, vent assemblies, sleeves, flashing, etc. specifically designed for application to the particular construction. Install system in accordance with the roofing manufacturer's instructions.

3.9 EXCAVATION AND BACKFILLING

A. General: Perform all necessary excavation and backfilling necessary for the installation of underground plumbing services as part of Division 22 in accordance with the architectural specifications.

3.10 GROUTING

A. Install nonmetallic nonshrink grout for plumbing equipment base bearing surfaces, pump and other equipment base plates, and anchors. Mix grout according to manufacturer's printed instructions.

B. Clean surfaces that will come into contact with grout.

C. Provide forms for placement of grout, as required.

D. Avoid air entrapment when placing grout.

E. Place grout to completely fill equipment bases.

F. Place grout on concrete bases to provide a smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout according to manufacturer's printed instructions.

3.11 CLEANING AND FINISHES

A. Clean surfaces prior to application of insulation, adhesives, coating, and paint.

B. Provide factory applied finish where specified.

C. Protect all finishes, and restore all finishes to their original condition if damaged as a result of work installed as part of the mechanical specifications.

D. Remove all construction marking and writing from exposed equipment, piping and building surfaces.

3.12 LINTELS

A. Lintels shall be provided for openings in masonry, brick, concrete, etc. walls to accommodate work of this division.

1. Lintels shall be provided under this division when not being provided under other divisions. Lintels shall be approved by the Architect.

3.13 ELECTRICAL REQUIREMENTS

A. Unless otherwise indicated, furnish and install control and interlock wiring for the equipment furnished under this division. In general, power wiring and motor starting equipment will be provided as specified in the electrical specifications.

1. Where the electrical requirements of the equipment furnished differ from the provisions made in the electrical specifications, make the necessary allowances as part of the mechanical specifications.
2. Where no electrical provisions are included in the electrical specifications, include all necessary electrical work as part of the mechanical specifications.

B. All electrical work performed as part of the mechanical specifications shall be provided in accordance with the electrical specifications.

3.14 PROVISIONS FOR ACCESS

A. Furnish and install adequate access to all plumbing components. The following list shall be used as a guide only:

1. Equipment
2. Valves
3. Cleanouts
4. Traps
5. Low point drains

B. Access shall be adequate as determined by the Architect.

C. Refer to contract drawings where access panels have been specifically located.

D. Where access is by means of lift out ceiling tiles or panels mark each access panel using small color coded or numbered tabs. Provide an index chart for identification. Place markers in corner of tile.

3.15 PENETRATION OF WATERPROOF CONSTRUCTION

A. Coordinate the work to minimize penetration of waterproof construction, including roofs, exterior walls and interior waterproof construction.

B. Furnish and install drains, curbs, vent assemblies, sleeves, flashing, etc. specifically designed for application to the particular construction. Install system in accordance with the roofing manufacturer's instructions.

3.16 OPERATION OF EQUIPMENT

A. Clean all systems and equipment prior to initial operation for testing and balancing.

B. Do not operate equipment unless all proper safety devices or controls are operational.

C. Provide all maintenance and service for equipment which is operated during construction.

D. Where specified and otherwise required, provide the services of a manufacturer's factory trained service organization to start the equipment.

3.17 TEMPORARY SERVICE AND EQUIPMENT USE

A. Temporary Service: Unless temporary services are required as part of the project, do not use plumbing systems for temporary services during construction unless authorized in writing by the Architect and/or UMB.

B. Equipment Use: Where such authorization is granted, temporary use of new and or existing equipment shall not limit or otherwise affect warranties or guarantees covering new equipment. Where equipment is used by the contractor the contractor shall perform all required preventive maintenance on the equipment during the construction period. Upon completion of work, clean and restore all new and/or existing equipment to new condition and replace all filters as necessary.

3.18 DEMONSTRATION AND INSTRUCTIONS

A. Demonstrate operation and maintenance of equipment and systems to Owner’s personnel a minimum two (2) weeks prior to date of final inspection.

1. For equipment requiring seasonal operation, perform instructions for other seasons at the same time.
2. Training period shall be performed within one (1), two (2) week period.

B. Use operation and maintenance manuals and video as basis of instruction. Review contents of manual and video with personnel in detail to explain all aspects of operation and maintenance.

C. Demonstrate the following:

1. Start up.
2. Operation.
3. Control.
4. Adjustment.
5. Trouble shooting.
6. Servicing.
7. Maintenance.
8. Shutdown.

D. Provide at least forty (40) hours straight time instruction to the operating personnel.

1. This instruction period shall consist of not less than five (5) eight (8) hour days.
2. Time of instruction shall be designated by the Owner.
3. This instruction shall be in addition to instructional requirements of specific equipment specified elsewhere in the mechanical specifications.

3.19 LUBRICATION

A. All bearings, motors and all equipment requiring lubrication shall be provided with accessible fittings.

B. Before turning over the equipment to the Owner, the Installer shall provide the following:

1. Fully lubricate each item of equipment.
2. Provide one (1) year's supply of lubricant for each type of lubricant.
3. Provide complete written lubricating instructions, together with diagram locating the points requiring lubrication.

C. Motors and equipment shall be provided with grease lubricated roller or ball bearings with Alemite or equal extended grease fittings and drain plugs.

3.20 WALL AND FLOOR PENETRATION

A. All penetrations of partitions, walls and floors by ducts, piping or conduit under Specification Division 22 shall be sealed and caulked. Provide U.L. listed fire stopping systems at penetrations through fire walls as specified in the architectural specifications.

3.21 EQUIPMENT PROVIDED UNDER ANOTHER DIVISION AND BY OTHERS

A. The Installer of products under Division 22 shall make all system connections required to equipment furnished and installed under another division and by others.

B. It shall be the responsibility of the Installer to obtain all necessary data from the equipment supplied under other Divisions.

3.22 CONSTRUCTION RECORD DRAWINGS

A. As the work progresses, the contractor shall record on one (1) set of prints, the installed locations, sizes, and depths of pipes, services, equipment, etc. which may differ from the approved contract drawings.

B. Upon completion of the plumbing system installations, the plumbing contractor shall deliver to the construction manager one (1) complete set of the plumbing system marked-up blueprints of the plumbing contract drawings.

1. The mark-ups shall be legibly marked in red pencil to show all changes and departures of the installation as compared with the original design.

C. At a minimum include the following installed conditions:

1. Location of all shut off valves, drain valves, and balancing valves with assigned valve tag numbers.
2. Show the location of concealed material and/or equipment requiring service such as strainers, point of use hot water heaters.
3. Actual entering/leaving invert elevations for domestic water, sanitary, storm water, services for the building.
4. Where building services are located below floor slabs show the actual low point invert elevation and the high point invert elevation for gravity piping systems.

3.23 CLOSEOUT PROCEDURES

A. Operating and Maintenance Instructions: Submit Complete Package At Least Two (2) Months Prior To Substantial Completion. Arrange for each installer of equipment that requires regular maintenance to meet with the Owner's personnel to provide instruction in proper operation and maintenance. If installers are not experienced in procedures, provide instruction by manufacturer's representatives. Include a detailed review of the following items:
1. Maintenance manuals, including a customized list of preventive maintenance items and annual schedule for maintenance.
2. Record documents.
3. Complete inventory of spare parts and materials.
4. Tools.
5. Lubricants.
6. Fuels.
7. Identification systems.
8. Control sequences.
9. Hazards.
10. Cleaning.
11. Warranties and bonds.
12. Maintenance agreements and similar continuing commitments.

B. As part of instruction for operating equipment, demonstrate the following procedures:

1. Start up.
2. Shut down.
3. Emergency operations.
4. Noise and vibration adjustments.
5. Safety procedures.
6. Economy and efficiency adjustments.
7. Effective energy utilization.

C. Pressure Vessel Inspections by the State of Maryland: For the purpose of obtaining and having UMB buildings insured by any commercial insurance carrier, the contractor shall arrange for the inspection of all pressure vessels installed during construction. The contractor shall contact the Office of Boiler and Pressure Vessel Inspections of the Department of Labor, Licensing and Regulations (DLLR), State of Maryland, and arrange for the inspections. The DLLR shall be notified at least thirty (30) days prior to installation. After such inspections are carried out by the State Inspector's office, Certificates of Compliance will be issued to the contractor of record to be turned over to the Owner's representative for compliance with current insurance regulations as part of the Project Documents. Examples of pressure vessels include boilers, heat exchangers, converters, expansion tanks, water heaters, hot water generators and storage tanks. Chillers are excluded and are covered under ASHRAE Guidelines.

3.24 FINAL CLEANING

A. General: General cleaning during construction is required by the General Conditions as indicated in Division 01 Specification Section "Temporary Facilities."

B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to the condition expected in a normal, commercial building cleaning and maintenance program. Comply with manufacturer's instructions.

C. Remove all mechanical clipping, wiring, nuts, bolts, etc. left on top of ceilings and ceiling tiles.

3.25 PROJECT PUNCH OUT

A. Architect/Engineer will perform punch out reviews and will provide the Contractor with a list of punch list items to be completed before contract close out. Each and every punch list item shall be initialed and dated by the Contractor when the work is complete. The Architect/ Engineer will not perform any punch list verification until all items have been completed, initialed, dated and the list returned to the Architect/Engineer. If any items have been initialed as being completed by the Contractor and the Architect/Engineer determines that the work is not complete, the Architect/Engineer shall be reimbursed by the Contractor at his regular hourly rate for any and all items requiring revisiting of the site by the Architect/Engineer. Reimbursement shall be made by deducting the Architect/Engineer fee from the Contractor's final payment.

END OF SECTION 220000

# SECTION 220517 – SLEEVES, SLEEVE SEALS, AND ECUTCHEONS FOR PLUMBING PIPING

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 22.

### 1.2 SUMMARY

A. This section includes the requirements for pipe sleeves, sleeve seals and escutcheons for piping systems using the following:

1. Pipe sleeves.
2. Sleeve-seal systems.
3. Grout.
4. Escutcheons.
5. Floor Plates.

### 1.3 ACTION SUBMITTALS

A. Product Data: For each product specified, include manufacturers cut sheets, dimensional data, performance data, installation instructions, specified options, and warranty information.

### 1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Include a copy of the approved submittal for each product and material along with any applicable maintenance data in the project operation and maintenance manual.

### 1.5 WARRANTY/GUARENTEE

A. See Division 22, Specification Section “Basic Mechanical Requirements – Plumbing” for warranty and guarantee requirements.

## PART 2 - PRODUCTS

### 2.1 GENERAL PRODUCT REQUIREMENTS

A. Equipment Design and Selection: Pipe sleeves, sleeve seals and escutcheons shall be designed and selected, for the intended use, in accordance with the details on the drawings and the requirements of this specification.

B. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. Sleeve Seal Systems:
   a. Advance Products & Systems, Inc.
   b. CALPICO, Inc.
   c. Metraflex Company (The).
   d. Pipeline Seal and Insulator, Inc.
   e. Proco Products, Inc.

2.2 PIPE SLEEVES

A. Steel Pipe Sleeves: Steel pipe sleeves shall be standard black steel pipe Type E, Grade B, with plain ends conforming to ASTM A53/A53M.

B. Cast Iron Pipe Sleeves: Cast iron pipe sleeves shall be standard weight cast iron pipe with plain ends conforming to ASTM A74 and CISPI – 301.

2.3 SLEEVE SEAL SYSTEMS

A. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

1. Sealing Elements: EPDM-rubber or NBR interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Stainless steel.
3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.4 GROUT

A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 5,000-psi, twenty eight (28) day compressive strength.

D. Packaging: Premixed and factory packaged.

2.5 ESCUTCHEONS

A. One (1) Piece, Cast-Brass Type, Deep-Pattern Type: With polished, chrome-plated and rough-brass finish and setscrew fastener.

B. One (1) Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.

C. Split-Casting Brass Type: With polished, chrome-plated and rough-brass finish and with concealed hinge and setscrew.

D. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed hinge, and spring-clip fasteners.

2.6 FLOOR PLATES

A. One (1) Piece Floor Plates: Cast-iron flange with holes for fasteners.

B. Split-Casting Floor Plates: Cast brass with concealed hinge.

**PART 3 - EXECUTION**

3.1 GENERAL

A. Install all Plumbing System sleeves, escutcheons, and associated components as required in accordance with the applicable codes and the best practices of the industry.

B. The work under this section shall be coordinated with that of all trades so that all work may be installed in the most direct and workmanlike manner and so that interference between piping, ducts, equipment, architectural and structural features will be avoided.

C. Coordinate clearance requirements with CM/GC for piping penetrating walls and floor slabs.

D. Mix grout with clean potable water; if grout is to be in contact with stainless-steel surfaces, use demineralized water.

E. Install accessories that do not corrode or soften in either a wet or dry state.

3.2 PIPE SLEEVE INSTALLATION

A. For Fire-Rated Assemblies (Floors, Walls, Ceilings):

1. Use standard weight steel pipe or service weight cast iron pipe for pipe sleeves. Where sleeves are installed in floors and load bearing walls, use only standard weight steel pipe for pipe sleeves.
2. Provide a minimum of one half (1/2) inch annular space clearance around the entire circumference of the pipe passing through the sleeve.
3. Center pipe passing through sleeve.
4. Do not continue insulation through sleeve.
5. The entire annular space must be sealed with fire stopping sealant.
6. Seal ends of pipe insulation and butt insulation ends up to fire stopping sealant in sleeve.
7. Sleeves in walls must be installed flush with both finished wall surfaces.

8. Sleeves in floors must be installed with top of sleeve one (1) inch above the finished floor surface. The bottom of the sleeve must be flush with the finished surface of the underside of the floor assembly.
9. In finished areas provide an escutcheon plate around the bare pipe or insulated pipe passing through the assemblies to conceal the sleeve and sealant. If a riser clamp is in place, omit the escutcheon.

B. For Non Fire-Rated Assemblies:

1. Floors:

   a. Use standard weight steel pipe or service weight cast iron pipe for pipe sleeves.
   b. Provide a minimum of one half (1/2) inch annular space clearance around the entire circumference of the pipe passing through the sleeve.
   c. Center pipe passing through sleeve.
   d. Do not continue insulation through sleeve.
   e. The entire annular space must be sealed with waterproof sealant.
   f. Seal ends of pipe insulation and butt insulation ends up to waterproof sealant in sleeve.
   g. Sleeves must be installed with top of sleeve one (1) inch above the finished floor surface. The bottom of the sleeve must be flush with the finished surface of the underside of the floor assembly.
   h. In finished areas provide an escutcheon plate around the bare pipe or insulated pipe passing through the assemblies to conceal the sleeve and sealant. If a riser clamp is in place, omit the escutcheon.

2. Walls:

   a. Use standard weight steel pipe or service weight cast iron pipe for pipe sleeves for masonry walls. Where sleeves are installed in load bearing walls, use only standard weight steel pipe for pipe sleeves in masonry walls.
   b. Use standard weight steel or service weight cast iron for pipe sleeve in frame walls.
   c. For non-insulated pipes, provide a minimum of one half (1/2) inch annular space clearance around the entire circumference of the pipe passing through the sleeve.
   d. For insulated pipes, provide a minimum of one half (1/2) inch annular space clearance around the entire circumference of the insulation.
   e. Center insulated pipe passing through sleeve.
   f. Continue insulation through sleeve.
   g. The entire annular space must be sealed with smoke and acoustic sealant.
   h. Sleeves in wall must be installed flush with both finished wall surfaces.

i. In finished areas provide an escutcheon plate around the bare pipe or insulated pipe passing through the assemblies to conceal the sleeve and sealant.

C. Sealant Requirements: Comply with requirements for sealants specified Architectural Specification Section "Joint Sealants".

D. Fire-Barrier Penetrations: Comply with requirements for firestopping specified in Architectural Specification Section "Penetration Firestopping".

3.3 SLEEVE SEAL SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.4 ECUTCHEONS INSTALLATION

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of insulated piping and with OD that completely covers opening.

C. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. New Piping: One (1) piece, floor-plate type.
2. Existing Piping: Split-casting, floor-plate type.

END OF SECTION 220517

# SECTION 220519 – THERMOMETERS AND GAUGES FOR PLUMBING PIPING

First Edition 5-16-2017

(Engineer shall edit specifications and blue text in header to meet project requirements. This includes but is not limited to updating Equipment and/or Material Model Numbers indicated in the specifications and adding any additional specifications that may be required by the project. Also turn off all "Underlines".)

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and the other sections of Division 22.

### 1.2 SUMMARY

A. Section includes the requirements for thermometers, and gauges using the following:

1. Vapor actuated thermometers.
2. Thermowells.
3. Dial-type pressure gauges.
4. Gauge attachments.
5. Test plugs.

### 1.3 ACTION SUBMITTALS

A. Product Data: For each product specified, include manufacturers cut sheets, dimensional data, performance data, installation instructions, wirings diagrams, power requirements, specified options, and warranty information.

### 1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of meter and gage, from manufacturer.

### 1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Include a copy of the approved submittal for each product and material along with any applicable maintenance data in the project operation and maintenance manual.

### 1.6 WARRANTY/GUARENTEE

A. See Division 22, Specification Section "Basic Mechanical Requirements – Plumbing" for warranty and guarantee requirements.

## PART 2 - PRODUCTS

### 2.1 GENERAL PRODUCT REQUIREMENTS

A. Equipment Design and Selection: Thermometers and gauges shall be designed and selected, for the intended use, in accordance with the requirements of this specification.

B. Acceptable Manufacturers: Subject to compliance with requirements, provide HVAC pumps by one (1) of the following:

1. Pressure Gauges:
   a. Trerice, H.O. Company.
   b. Weiss Instruments, Inc.
   c. Weksler Instrument Corp.

2. Test Plugs:
   a. Trerice, H.O. Company.
   b. Flow Design Inc.
   c. Peterson Equipment Company Inc.

### 2.2 THERMOWELLS

A. Thermowells:

1. Standard: ASME B40.200.
2. Description: Brass or stainless-steel thermometer well.
3. Pressure Rating: Not less than piping system design pressure.
4. Stem length: To extend two (2) inches into fluid or center of pipe, whichever, is shorter.
5. Extension for Insulated Piping: Two (2) inches nominal, but not less than thickness of insulation.
6. Threaded Cap Nut: With chain permanently fastened to well and cap.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

### 2.3 PRESSURE GAUGES

A. General Requirements:

1. Provide pressure gauges were indicated on the drawings and as specified.
2. Service and Scale Range in pounds per square inch (PSI):

   a. Domestic Cold Water: Zero (0) to two (2) times operating pressure.

B. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. Standard: ASME B40.100.

2. Case: Liquid-filled type; cast aluminum or drawn steel; four and one half (4-1/2) inch nominal diameter.
3. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
4. Match pressure connection size in first subparagraph below with gage attachment size.
5. Pressure Connection: Brass, with NPS 1/4, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
8. Pointer: Dark-colored metal.
9. Window: Glass.
10. Ring: Metal.
11. Accuracy: Grade A, plus or minus one (1) percent of scale range.

C. Gage Attachments: Provide gage attachments as indicated below:

1. Syphons: one quarter (1/4) inch straight coil of brass tubing with threads on each end.
2. Gage Valves: Provide gage valves (specialty valves) as specified in Division 22 Specification Section “Valves for Plumbing Piping Systems”.

2.4 TEST PLUGS

A. Description: Nickel plated brass body test plug in one half (1/2) inch fitting.

B. Body: Length as required to extend beyond insulation.

C. Pressure Rating: 500 psig minimum.

D. Core Inserts: Two (2) self-sealing valve types, suitable for inserting a one eighth (1/8) inch (3mm) outside-diameter probe from a dial thermometer or pressure gage.

E. Core Material: According to the following for fluid and temperature range:

1. Air, Water, Glycol Oil, and Gas: 20ºF to 200ºF, neoprene rubber.
2. Air and Water: -30°F to 275°F (-35°C to 136°C), ethylene-propylene-diene-terpolymer (EDPM) rubber.

F. Test Plug Cap: Gasketed and threaded cap, with retention chain.

G. Test Kit: Provide test kit consisting of one (1) pressure gage and gage adapter with probe, two (2) bimetal dial thermometers and a carrying case

H. Pressure Gage and Thermometer Ranges: Approximately two (2) times systems operating conditions.

I. Body: Length as required to extend beyond insulation.

**PART 3 - EXECUTION**

3.1 INSTALLATION

A. Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of thermometers and gages in the piping systems. So far as practical, install thermometers and gages as indicated.

3.2 THREMOWELLS

A. Install thermowells with socket extending a minimum of two (2) inches into fluid or center of pipe, whichever is shorter.

B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium.

3.3 PRESSURE GAGES

A. Install pressure gauges in the following locations:

1. Building water service entrance into building.
2. Inlet and outlet of each pressure-reducing valve.

B. Install direct-mounted pressure gauges in piping tees with pressure gauge located on pipe at the most readable position.

C. Install remote-mounted pressure gauges on panel.

D. For gauge valves see Division 22 Specification Section “Valves for Plumbing Piping Systems”.

E. Install test plugs in piping tees.

3.4 CONNECTIONS

A. Install thermometers and gauges adjacent to machines and equipment to allow service and maintenance of thermometers, gauges, machines, and equipment.

3.5 ADJUSTING

A. Adjust faces of thermometers and gauges to proper angle for best visibility.

B. Calibrate meters according to manufacturer's written instructions, after installation.

C. Adjusting: Adjust faces of meters and gages to proper angle for best visibility.

D. Cleaning: Clean windows of meters and gages and factory finished surfaces. Replace cracked and broken windows and repair scratched and marred surfaces with manufacturer's touchup paint.

END OF SECTION 220519

# SECTION 220523 – VALVES FOR PLUMBING PIPING SYSTEMS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 23.

### 1.2 SUMMARY

A. This section includes the requirements for shutoff, drain, specialty, and check valves installed in plumbing piping systems as follows:

1. Plumbing System ball valves.
2. Plumbing System check valves.
3. Plumbing System special valves.
4. Special Valves.

### 1.3 ACTION SUBMITTALS

A. Product Data: For each product specified, include manufacturers cut sheets, dimensional data, performance data, installation instructions, accessories, specified options, and warranty information. Identify valves for each plumbing system application.

### 1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Include a copy of the approved submittal for each product and material along with any applicable maintenance data in the project operation and maintenance manual.

B. Additional Data: In addition to the approved submittals, for each valve type, include the manufacturers printed exploded view type parts and material list indicating how to dismantle, repair and reassemble the valve, and identifying each part.

### 1.5 QUALITY ASSURANCE

A. Installer Qualifications: The installer shall be a qualified licensed installer within the jurisdiction and familiar with the installation of the valves specified herein for each piping system.

B. Compliance: Comply with the following:

1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
2. ASME B31.1 for power piping valves.
3. ASME B31.9 for building services piping valves.
4. NSF Compliance: NSF 61 for valve materials for potable-water service.

C. ProPress Valve Compliance: Valves in propress piping systems shall be in compliance with ASME B31.9 for building service piping valves.

D. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

1.6 PERFORMANCE REQUIREMENTS

A. Compatibility: Products shall be suitable for piping service fluids, materials, working pressures, and temperatures.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Information in this article is paraphrased from MSS.

B. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set ball and plug valves open to minimize exposure of functional surfaces.
4. Set butterfly valves closed or slightly open.
5. Block check valves in either closed or open position.

C. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

D. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

1.8 WARRANTY/GUARANTEE

A. See Division 22 Specification Section “Basic Mechanical Requirements – Plumbing” for warranty and guarantee requirements.

## PART 2 - PRODUCTS

2.1 GENERAL PRODUCT REQUIREMENTS

A. Equipment Design and Selection: Valves shall be designed and selected, for the intended use, in accordance with the requirements of this specification.

B. Acceptable Manufacturers: Subject to compliance with requirements, provide lead free plumbing valves by one (1) of the following:

1. Ball Valves – Copper and Steel Piping Systems:
   a. Apollo.
   b. Milwaukee.
   c. Watts.
   d. Nibco.
   e. Viega.

2. Check Valves – Copper and Steel Piping Systems:
   a. Apollo.
   b. Milwaukee.
   c. Watts.

3. Special Valves:
   a. Watts.
   b. Spence.
   c. Wilkens.

C. See shut off, drain, & specialty valve application below for required valves.

D. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

E. Valve Sizes: Same as upstream/downstream piping unless otherwise indicated.

F. Valve Actuator Types:

1. Handlever: For quarter-turn valves NPS 6 and smaller.

G. Valves in Insulated Piping: With two (2) inch stem extensions and the following features:

1. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.

H. Valve-End Connections:

1. Threaded Ball Valves: With threads according to ASME B1.20.1.
2. Press End Ball Valves: Where pro press piping systems are used.

2.2 SHUT OFF, DRAIN, AND SPECIALITY VALVE APPLICATIONS

A. General Application: All Valves installed in Plumbing Piping Systems shall be as specified below. For this application, Plumbing Piping Systems and Specialty Valves are defined as follows:

1. Domestic (Potable) Water System: Includes Cold Water, Hot Water, Piping utilizing solder joint and/or pro press joint method.
2. Specialty Valves: Valves used at connections for P/T Plugs, DP Switches, & Pressure Gages.
3. Special Valves: Used as solenoid valves and pressure reducing valves.

B. Shut Off, Drain and Specialty Valves – UMB Campus: Gate Vales will not be permitted for installation in these systems. Only listed manufacturers and model numbers below are acceptable to UMB.

1. Shut Off Valves for Domestic Water Solder Joint Piping Systems One Half (1/2) Inch to Two (2) Inch: Use Two (2) Piece Full Port Lead Free Ball Valves and Trim as indicated below:

a. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1) Conbraco Industries, Inc. Apollo Valves: 77FLF-140 Series, Brass Body.
2) Milwaukee Valve Company: UPBA400S Series, Bronze Body.
3) Watts Water Technologies: LFB6080, Brass Body.
4) Nibco Inc.: T-685-66 LF, Bronze Body.

b. Description:

1) Standard: MSS SP-110.
2) SWP Rating: 150 psig.
3) CWP Rating: 600 psig.
4) Body Design: Two (2) piece.
5) Body Material: Bronze or Brass.
6) Ends: Threaded.
7) Seats: Modified Teflon double seal seats and Teflon seals.
8) Stem: Type 316 Stainless steel.
9) Ball: Type 316 Stainless steel, vented.
10) Port: Full.

11) Handle: Lever Type.
12) Lead free valves.
13) For valves used as combination balancing/shut off duty on HWR systems, provide memory stops.

2. Shut Off Valves for Domestic Water ProPress Piping Systems One Half (1/2) Inch to One and One Quarter (1 1/4) Inch: Use Two (2) Piece Full Port Lead Free Ball Valves and Trim as indicated below:

a. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1) Viega: 2971.1ZL, Bronze Body
2) Conbraco Industries, Inc. Apolloxpress 77WLF-140, Bronze Body.
3) Milwaukee: UPBA480S, Brass Body.

b. Description:

1) Standard: MSS SP-110.
2) SWP Rating: 150 psig.
3) CWP Rating: 600 psig.
4) Body Design: Two (2) piece.
5) Body Material: Bronze or Brass.
6) Ends: Press ends, smart connect feature.
7) Seats: EPDM
8) Stem: Type 316 Stainless steel.
9) Ball: Type 316 Stainless steel, vented.
10) Port: Full.
11) Handle: Lever Type.
12) Lead free valves.
13) For valves used as combination balancing/shut off duty on HWR systems, provide memory stops.

3. Shut Off Valves for Domestic Water ProPress Piping Systems One and One Half (1-1/2) Inch and Two (2) Inch: Use Two (2) Piece Full Port Lead Free Ball Valves and Trim as indicated below:

a. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1) Viega: 2970.3ZL, Bronze Body
2) Conbraco Industries, Inc. Apolloxpress: 77WLF-140, Bronze Body.
3) Milwaukee: UPBA480S, Brass Body.

b. Description:

1) Standard: MSS SP-110.
2) SWP Rating: 150 psig.
3) CWP Rating: 600 psig.
4) Body Design: Two (2) piece.
5) Body Material: Bronze or Brass.
6) Ends: Press ends, smart connect feature.
7) Seats: EPDM
8) Stem: Stainless steel.
9) Ball: Type 316 Stainless steel, vented.
10) Port: Full.
11) Handle: Lever Type.
12) Lead free valves.
13) For valves used as combination balancing/shut off duty on HWR systems, provide memory stops.

4. Shut Off Valves for Domestic Water Solder Joint Piping Systems Two and One Half (2-1/2) Inch and Larger: Use 200 CWP, Cast Iron, Flanged Butterfly Valves with EPDM Seat and Stainless Steel or Coated Ductile Iron Disc:

a. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1) ABZ Valve and Controls; a division of ABZ Manufacturing, Inc. Series 929.
2) Bray Series 31 with Trim 119.
3) Milwaukee ML223E.

b. Description:

1) Standard: MSS SP-67, Type I.
2) CWP Rating: 200 psig.
3) Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
4) Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
5) Seat: EPDM.
6) Stem: One (1) or two (2) piece stainless steel.
7) Disc: Stainless steel or lead free nylon 11 coating on a ductile iron disk.
8) Handle: Wheel Type, Chain Operator, or Gear Operator.

5. Drain Valves for Domestic Water Solder Joint Piping Systems One Half (1/2) Inch to Two (2) Inch: Use Three Quarter (3/4) inch, Two (2) Piece Full Port Lead Free Ball Valves and Trim as indicated below:

   a. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

      1) Conbraco Industries, Inc. Apollo Valves: 77FLF-140, Brass Body.
      2) Milwaukee Valve Company: UPBA400S, Bronze Body.
      3) Watts: LFB6080, Brass Body
      4) Nibco Inc.: T-685-66-LF, Bronze Body.

   b. Description:

      1) Standard: MSS SP-110.
      2) SWP Rating: 150 psig.
      3) CWP Rating: 600 psig.
      4) Body Design: Two piece.
      5) Body Material: Bronze, or Brass.
      6) Ends: Threaded.
      7) Seats: Modified Teflon double seal seats and Teflon seals..
      8) Stem: Type 316 Stainless steel.
      9) Ball: Type 316 Stainless steel, vented.
      10) Port: Full.
      11) Handle: Lever Type.
      12) Lead free valves.
      13) Three Quarter (3/4) inch capped hose connection.

6. Drain Valves for Domestic Water ProPress Piping Systems One Half (1/2) Inch to Two (2) Inch: Use Three Quarter (3/4) Piece Full Port Lead Free Ball Valves and Trim as indicated below:

   a. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

      1) Viega: 2971.3ZL, Bronze Body.
      2) Conbraco Industries, Inc. Apollo Valves: 77WLF-140, Bronze Body.
      3) Milwaukee: UPBA – 480S, Brass Body.

   b. Description:

      1) Standard: MSS SP-110.
      2) SWP Rating: 150 psig.
      3) CWP Rating: 600 psig.

4) Body Design: Two (2) piece.
5) Body Material: Bronze or Brass.
6) Ends: Press ends, smart connect feature.
7) Seats: Modified Teflon double seal seats and Teflon seals.
8) Stem: Type 316 Stainless steel.
9) Ball: Type 316 Stainless steel, vented.
10) Port: Full.
11) Handle: Lever Type.
12) Lead free valves.

7. Drain Valves for Domestic Water Solder Joint Piping Systems Two and One Half (2-1/2) Inch and Larger: Use Two and One Half (2-1/2) Inch, Two (2) Piece Full Port Lead Free Ball Valves with Stainless Steel Trim as indicated below:

a. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1) Conbraco Industries, Inc. Apollo Valves: 77FLF-140 Series, Brass Body.
2) Milwaukee Valve Company: UPBA400S Series, Bronze Body.
3) Watts Water Technologies: LFB6080, Brass Body.
4) Nibco Inc.: T-685-66 LF, Bronze Body.

b. Description:

1) Standard: MSS SP-110.
2) SWP Rating: 150 psig.
3) CWP Rating: 600 psig.
4) Body Design: Two piece.
5) Body Material: Bronze or Brass.
6) Ends: Threaded.
7) Seats: Modified Teflon double seal seats and Teflon seals..
8) Stem: Type 316 Stainless steel.
9) Ball: Type 316 Stainless steel, vented.
10) Port: Full.
11) Handle: Lever Type.
12) Lead free valves.
13) Two and One Half (2-1/2) inch capped fire hose connection.

8. Specialty Valves for Domestic Water Solder Joint Piping Systems: Use One Quarter (1/4) Inch, Two (2) Piece Full Port Lead Free Ball Valves and Trim as indicated below:

a. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1) Conbraco Industries, Inc. Apollo Valves: 77FLF-140 Series, Brass Body.
2) Milwaukee Valve Company: UPBA400S Series, Bronze Body.
3) Watts Water Technologies: LFB6080, Brass Body.
Nibco Inc.: T-685-66 LF, Bronze Body.

b. Description:

1) Standard: MSS SP-110.
2) SWP Rating: 150 psig.
3) CWP Rating: 600 psig.
4) Body Design: Two piece.
5) Body Material: Bronze or Brass.
6) Ends: Threaded.
7) Seats: Modified Teflon double seal seats and Teflon seals.
8) Stem: Type 316 Stainless steel.
9) Ball: Type 316 Stainless steel, vented.
10) Port: Full.
11) Handle: Lever Type.
12) Lead free valves.

9. Specialty Valves for Domestic Water ProPress Piping Systems: Use One Half (1/2) Inch, Two (2) Piece Full Port Lead Free Ball Valves and Trim as indicated below:

a. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1) Viega: 2971.3ZL, Bronze Body.
2) Conbraco Industries, Inc. Apollo Valves: 77WLF-140, Bronze Body.
3) Milwaukee: UPBA – 480S, Brass Body.

b. Description:

1) Standard: MSS SP-110.
2) SWP Rating: 150 psig.
3) CWP Rating: 600 psig.
4) Body Design: Two piece.
5) Body Material: Bronze or Brass.
6) Ends: Press end, smart connect feature.
7) Seats: EPDM
8) Stem: Type 316 Stainless steel.
9) Ball: Type 316 Stainless steel, vented.

10) Port: Full.
11) Handle: Lever Type.
12) Lead free valves.

## 2.3 CHECK VALVES

A. General: All check valves used in Domestic Water Piping Systems shall be lead free construction.

B. Bronze Lift Check Valves – Metallic Disc: Use Class 125, Lift Check Valves with Bronze Disc as indicated below:

1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

a. Apollo
b. Milwaukee Valve Company.
c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-80, Type 1.
b. CWP Rating: 200 psig.
c. Body Design: Vertical flow.
d. Body Material: ASTM B 61 or ASTM B 62, bronze.
e. Ends: Threaded.
f. Disc: Bronze.
g. Lead free valves.

C. Bronze Lift Check Valves – Nonmetallic Disc: Class 125, Lift Check Valves with Nonmetallic Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

a. Apollo
b. Milwaukee Valve Company.
c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-80, Type 2.
b. CWP Rating: 200 psig.
c. Body Design: Vertical flow.
d. Body Material: ASTM B 61 or ASTM B 62, bronze.

e. Ends: Threaded.
f. Disc: NBR, PTFE, or TFE.
g. Lead free valves.

D. Bronze Swing Check Valves – Metallic Disk: Use Class 125, Bronze Swing Check Valves with Bronze Disc as indicated below:

1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

a. Apollo.
b. Milwaukee Valve Company.
c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-80, Type 3.
b. CWP Rating: 200 psig.
c. Body Design: Horizontal flow.
d. Body Material: ASTM B 62, bronze.
e. Ends: Threaded.
f. Disc: Bronze.

E. Bronze Swing Check Valves – Nonmetallic Disk: Use Class 125, Bronze Swing Check Valves with Nonmetallic Disc as indicated below:

1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

a. Apollo.
b. Milwaukee Valve Company.
c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-80, Type 4.
b. CWP Rating: 200 psig.
c. Body Design: Horizontal flow.
d. Body Material: ASTM B 62, bronze.
e. Ends: Threaded.
f. Disc: PTFE or TFE.
g. Lead free valves.

2.4 SPECIAL VALVES

A. Water Temperature Limiting Devices:

1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

   a. Powers; a division of Watts Water Technologies, Inc.
   b. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
   c. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.

2. Standard: ASSE 1070.
3. Pressure Rating: 125 psig.
4. Type: Thermostatically controlled, water mixing valve.
5. Material: Bronze body with corrosion-resistant interior components.
6. Connections: Threaded inlets and outlet.
7. Accessories: Check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.

**PART 3 - EXECUTION**

3.1 GENERAL

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Valves shall be placed in such manner as to be easily accessible for smooth and easy hand wheel operation and packing maintenance.

B. Install valves in piping where shown and where listed herein:

1. To balance flows in water piping systems.
2. To isolate all items of equipment.

3. To isolate motorized flow control valves.
4. To isolate branch lines and risers at mains.
5. To drain low points in piping systems.
6. To drain pipe risers.
7. To drain equipment.
8. To drain trapped sections in the piping system.

C. Where piping or equipment may be subsequently remove, provide valves with bodies having integral flanges or full lugs drilled and tapped to hold valve in place so that downstream piping or equipment can be disconnected and replaced with blank-off plate while valve is still in service.

D. Valves for equipment and controls shall be installed full size of pipe before reducing size to make equipment connection.

E. Where there is no interference, shut-off valves shall be installed with handwheel up on horizontal runs of pipe to prevent accumulation of foreign matter in working parts of valves. In no case shall the stem be installed below the pipe centerline.

F. On valves, strainers, etc., installed in copper piping, provide a union on the discharge side of each valve and threaded adapters where copper piping connects to valves, strainers, etc.

G. Drawings indicate the general arrangement of piping, fittings, and specialties.

H. Install valves with unions or flanges at each piece of equipment arranged to allow servicing, maintenance, and equipment removal without system shutdown.

I. Install valves in a position to allow full handle movement.

J. Install safety relief valves on hot water generators, boilers, pressure vessels, etc. and elsewhere as required by ASME Boiler and Pressure Vessel Code. Pipe discharge without valves as shown on drawings, or to nearest floor drain if not shown on drawings. Comply with ASME Boiler and Pressure Vessel Code Section VIII, Division 1 for installation requirements.

K. Install shut-off valves upstream and downstream of each pressure regulator.

L. Where threaded ball valves are installed in brazed copper piping systems braze each threaded adapter on to the piping. After each adapter has cooled to the touch install the threaded ball valve. Do not connect the threaded adapter to the valve and then braze the adapter and valve to the piping as this will result in damage to the valve seals. If any valve, in the brazed piping systems are damaged due to faulty installation the damaged valves shall be replaced by the contractor at no cost to the University.

M. Where butterfly valves are installed in copper piping systems provide companion flanges and dielectric gasket kits for each flange. When valves and/or fittings are installed in piping where electrolysis may occur provide dielectric unions at each connection.

N. Locate valves for easy access and provide separate support where necessary.

O. Install valves in horizontal piping with stem at or above center of pipe.

P. Install valves in position to allow full stem movement.

Q. Where solder end three (3) piece ball valves without tube extensions are installed in brazed copper piping systems, each valve shall be disassembled prior to installation. After the end sections are brazed to the pipe and after they have been cooled to the touch each valve shall be reassembled. Failure to disassemble the valve before brazing will result in damage to the valve seals. If any valve, in the brazed piping systems are damaged due to faulty installation the damaged valves shall be replaced by the contractor at no cost to the University.

R. Where solder end three (3) piece ball valves with tube extensions are installed in brazed copper piping systems, each valve shall be disassembled prior to installation. After the tube extensions have been brazed to the pipe and after they have been cooled to the touch each valve shall be reassembled. The manufacturer recommends the valve assembly be installed with one tube extension being covered with wet rags and the joint brazed. After the brazed tube extension has cooled to the touch, cover the other tube extension with wet rags and braze the joint. Do not braze the second tube extension while the first tube extension is still hot as this will result in damage to the valve seals. If any valve, in the brazed piping systems are damaged due to faulty installation the damaged valves shall be replaced by the contractor at no cost to the University.

S. Install balancing valves with memory stops in locations where they can easily be adjusted.

T. Install check valves for proper direction of flow and as follows:

1. Swing Check Valves: In horizontal position with hinge pin level.
2. Lift Check Valves: With stem upright and plumb.

## 3.3 SPECIAL VALVE APPLICATIONS

A. Install solenoid valves where indicated on the drawings and where required as make up water valves for HVAC Systems. See Division 23 Specification Sections for Building Automation Systems for interface with the BAS.

B. Install pressure-reducing valves at makeup-water connection to regulate system pressure.

3.4 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.5 THREADED CONNECTIONS

A. Note the internal length of threads in valve ends and proximity of valve internal seat or wall to determine how far pipe should be threaded into valve.

B. Align threads at point of assembly.

C. Apply appropriate tape or thread compound to the external pipe threads, except where dry seal threading is specified.

D. Assemble joint, wrench tight. Wrench on valve shall be on the valve end into which the pipe is being threaded.

3.6 FLANGED CONNECTIONS

A. Align flange surfaces parallel.

B. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly with a torque wrench.

C. For dead-end service, butterfly valves require flanges both upstream and downstream for proper shutoff and retention.

3.7 PRESS END CONNECTIONS

A. Press connections shall be made according to the manufacturer’s installation instructions.

B. Where thread end valves are installed in press end piping systems, provide threaded adaptors for each valve and follow manufacturer’s installation instructions.

C. Where flanged valves are installed in press end piping systems, provide flange connections for each valve and follow manufacturer’s installation instructions.

END OF SECTION 220523

# SECTION 220529 – HANGERS AND SUPPORTS FOR PLUMBING SYSTEMS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 22.

### 1.2 SUMMARY

A. This section includes the requirements for hangers and supports for plumbing piping equipment as follows:

1. Metal pipe angers and supports.
2. Trapeze pipe hangers.
3. Thermal hanger shield inserts.
4. Fastener systems.
5. Pipe positioning system.
6. Pipe supports and curbs at roof level.
7. Miscellaneous materials

### 1.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
3. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

### 1.4 ACTION SUBMITTALS

A. Product Data: For each product specified, include manufacturers cut sheets, dimensional data, performance data, installation instructions, specified options, and warranty information.

### 1.5 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Include a copy of the approved submittal for each product and material along with any applicable maintenance data in the project operation and maintenance manual.

1.7 QUALITY ASSURANCE

A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

1.8 WARRANTY/GUARANTEE

A. See Division 22, Specification Section “Basic Mechanical Requirements – Plumbing” for warranty and guarantee requirements.

**PART 2 - PRODUCTS**

2.1 GENERAL PRODUCT REQUIREMENTS

A. Equipment Design and Selection: Hangers and supports shall be designed and selected, for the intended use, in accordance with the details on the drawings and the requirements of this specification.

B. Acceptable Manufacturers: Subject to compliance with requirements, provide comparable product by one (1) of the following:

1. Metal Pipe Hangers and Supports:
   a. B-Line.
   b. Fee and Mason.
   c. Anvil.
   d. Michigan Hanger.

2. Thermal-Hanger Shield Inserts (Pre-Insulated Pipe Supports):
   a. Pipe Shields, Inc. (Piping technology & Products, Inc.)
   b. Bergen Pre-Insulated Pipe Supports
   c. Rilco.

3. Thermal-Hanger Shield Inserts:
   a. Pipe Shields, Inc. (Piping technology & Products, Inc.)
   b. Bergen Pre-Insulated Pipe Supports

c. Rilco.

4. Fastener Systems (Concrete Anchors):
   a. Hilti,
   b. Powers Fasteners or
   c. Red Head

5. Metal Framing Support System:
   a. Unistrut,
   b. B-Line Strut Systems
   c. Anvil-Strut
   d. Kindorf
   e. Hilti

6. Pipe Guides and Anchors:
   a. Shaw Pipe Shields
   b. Bergen Pre-Insulated Pipe Supports
   c. Rilco

7. Pipe and Equipment Supports - Roof Level:
   a. Pate Company.
   b. Roof Products and Systems (RPS).
   c. Tybar Corporation.

2.2 PIPE HANGERS AND SUPPORTS

A. Horizontal non-insulated, waste, vent and storm water piping hangers:

1. Two (2) inch and smaller Figure No. kB3170.
2. Two and one-half (2-1/2) inch and larger: Figure No. B3100.
3. Galvanized Metallic Coatings: Pre-galvanized or hot dipped.
4. Nonmetallic Coatings: Plastic coating, jacket, or liner.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Horizontal Non-Insulated Copper Piping Hangers:

1. Two (2) inch and smaller: Figure NO. B3104 CT.
2. 2-1/2) inch and larger: Figure No. B3104 CT.

C. Insulated Horizontal Piping Hangers: Cold and Hot Water (Domestic):

1. Two (2) inch and smaller: Figure No. B3108 with metal shield, Figure No. B3151.
2. Two and one-half (2-1/2) inch and larger: Figure No. B3108 with metal shield, Figure No. B3151.

2.3 TRAPEZE PIPE HANGERS

A. Description: Direct mounting hangers:

1. Grinnell No. 46.

2.4 THERMAL-HANGER SHIELD INSERTS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.

B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.

C. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.

D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

F. Insert Length: Extend two (2) inches beyond sheet metal shield for piping operating below ambient air temperature.

2.5 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.6 PIPE POSITIONING SYSTEMS

A. Description: IAPMO PS 42, positioning system of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.

2.7 FABRICATED EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

B. Delegated Design: Calculate requirements for support of equipment weight and restraint of both lateral and vertical dynamic forces at 150% of operating conditions.

C. Details: Detail fabrication of each support assembly. Show dimensions and methods of assembly and attachment to building structure.

2.8 PIPE SEALS AND CURBS - ROOF LEVEL

A. General: Where piping systems and conduits for power and controls serve HVAC equipment located above the roof level where indicated on the drawings and as specified.

B. Pipe Seal Assembly: Model PPS, for a single pipe application, shall be a one piece spun aluminum base with full five (5) inch sloped roof surface flange, graduated step PVC boot and adjustable stainless steel clamp.

C. Pipe Supports: Pipe supports shall be one (1) of the following:

1. Equipment Support Without Pipe Rollers: Pate Style ES equipment supports constructed of 18 gauge galvanized steel, unitized construction with integral base, continuous welded corner seams, pressure treated two (2) x four (4) wood nailer and counterflashing with galvanized screws. The overall height for each support shall be eighteen (18) inches from the finished roof to the top of the counterflashing plus the height of the pipe supports and the pipe. Contractor shall provide galvanized Unistrut type channel tracts, with galvanized washers, nuts, bolts, and pipe clamps to secure the pipe to the tract and the track to the equipment support.
2. Equipment Support With Pipe Rollers: Pate Style PRS or MPRS equipment supports constructed of heavy gage galvanized steel, unitized construction with integral base, continuous welded corner seams, pressure treated (2) x four (4) wood nailer and counterflashing with galvanized screws. Roller assembly shall include galvanized steel channel tracks, galvanized steel fittings, washers, nuts, bolts, and painted cast iron rollers. The overall height for each support shall be eighteen (18) inches from the finished roof to the top of the counterflashing plus the height of the pipe rack. Contractor shall provide galvanized insulation shields to protect the pipe insulation at each support point.

D. Pipe Curbs: Pipe curbs for pipes up to six (6) inches with or without insulation shall be as follows:

1. Pipe Curb Assembly: Pate Style PCC series pipe curb assembly constructed of heavy gauge galvanized steel, unitized construction with integral base plate, one

and one half (1-1/2) inch insulation, pressure treated two (2) inch x two (2) inch wood nailer. The overall height for each curb shall be eighteen (18) inches from the finished roof level to the top of the pipe cover. Assembly shall be furnished with an acrylic clad thermoplastic cover, galvanized fastening screws and graduated step boots with stainless steel clamps fit around the pipe risers passing through the curb assembly and cover. Mechanical contractor shall coordinate with Pate to provide the appropriate cap and boot package for the installed pipe with pipe insulation in the submittal package.

2.9 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, twenty eight (28) day compressive strength.
3. Water: Potable
4. Packaging: Premixed and factory-packaged.

C. Washers: ASTM F 844, steel, plain, flat washers.

D. Vertical Piping Riser Clamps:

1. Copper Pipe: Figure No. B3373CT.
2. Steel Pipe: Figure No. B3136 and B3137.

E. Beam Clamps and Attachments:

1. For bolt-on locations to structure, Figure Nos. B3291, B3036, B3050.
2. Welded beam attachments, Figure No. B3083.

F. Concrete Inserts:

1. For concrete spot inserts at single locations for casting into structure, Figure No. B3014 for pre- determined rod size and Figure No. B2500 for universal use.
2. For continuous slot concrete insert at multi-locations for casting into structure, Figure No. B2505.

G. Brackets:

1. For equipment and piping adjacent to walls or steel columns, Figure Nos. B3066, B3063 and B3067 depending on weight to be supported.

H. Pipe Rests:

1. For pipes close to floor where no expansion provision is required, Figure No. B3088T base stand with B3093 adjustable pipe saddles support.

I. Hanger Rods:

1. Hanger rod, Figure No. B3205.
2. Continuous threaded rod, Figure No. ATR.
3. Eye rods, Figure No. B3210 or B3211, depending on load supported.

J. Spring Hangers:

1. Light loads, movement less than 1-1/4 inches, Figure No. B3262 or B3264.

K. Protection Saddles:

1. Cast iron pipe, insulated, Figure No. B3108 with metal shield, Figure No. B3151.
2. For high temperature steel pipe, insulated, No. B3160, B3161, B3162, B3163, B3164, or B3165.

## PART 3 - EXECUTION

### 3.1 GENERAL INSTALLATION REQUIREMENTS

A. Install supports to allow for free expansion of piping. Support piping from building structural members using concrete inserts, beam clamps, ceiling plates, wall brackets, or floor stands. At no time shall hangers and supports overload building structural members. Fasten ceiling plates and wall brackets securely to structure and test to demonstrate adequacy of fastening.

B. Select and size building attachments properly in accordance with MSS Standards and manufacturer's published load rating information.

C. Coordinate hanger and support installation to properly group piping of all trades.

D. Suspend hangers by means of hanger rods. Perforated band iron and flat wire (strap iron) are not allowed.

E. Piping and ductwork shall be supported independently from other piping or ductwork.

F. Pipe hangers and supports shall not penetrate vapor barrier of pipe insulation.

G. Do not support equipment, piping or ductwork from metal roof decking or ceiling grid.

H. Install adequate supports so as not to over stress either piping or equipment to which piping is connected.

## 3.2 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly supported piping from the building structure.

1. Horizontal Piping: Support horizontal piping within twelve (12) inches of each fitting and coupling.
2. Base of Vertical Piping: Provide MSS Type 52, spring hangers.
3. Vertical Pipe Supports: Install supports for vertical steel pipe and copper tubing at each floor level.
4. Individual, Straight, Horizontal Piping Runs:

    a. One hundred (100) Feet and Less: MSS Type 1, adjustable, steel, clevis hangers.
    b. Longer than One Hundred (100) Feet: MSS Type 43, adjustable, roller hangers.
    c. Longer than One hundred (100) Feet if Indicated: MSS Type 49, spring cushion rolls.
    d. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
    e. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
    f. Install stainless-steel pipe support clamps for vertical piping in corrosive environments

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
3. Multiple, Straight, Horizontal Piping Runs One hundred (100) Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.

C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.

D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

E. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than four (4) inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

F. Pipe Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.

G. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

H. Equipment support in first paragraph below requires calculating and detailing at each use.

I. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

J. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

K. Install lateral bracing with pipe hangers and supports to prevent swaying.

L. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 (DN 65) and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

M. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

N. Upper attachments to structures shall have an allowable load not exceeding one quarter (1/4) of the failure (proof test) load but are not limited to the specific methods indicated.

O. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

P. Insulated Piping:

1. Attach clamps and spacers to piping.

a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:

a. NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90): Twelve (12) inches long and 0.048 inch thick.
b. NPS 4 (DN 100): Twelve (12) inches long and 0.06 inch thick.
c. NPS 5 and NPS 6 (DN 125 and DN 150): Eighteen (18) inches long and 0.06 inch thick.
d. NPS 8 to NPS 14 (DN 200 to DN 350): Twenty four (24) inches long and 0.075 inch thick.
e. NPS 16 to NPS 24 (DN 400 to DN 600): Twenty four (24) inches long and 0.105 inch thick.

5. Pipes NPS 8 (DN 200) and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

Q. Conform to the table below for maximum spacing of supports and rod sizes:

1. Steel and Copper Pipe:

| | Steel Pipe | Copper Tube | |
|---|---|---|---|
| Nom. Pipe Size - In. | Max. Span - Ft. (In) | Max. Span - Ft. (In) | Min. Rod Dia. – In. |

| | | | |
|---|---|---|---|
| Up to 3/4 | 7 (84) | 5 (60) | 3/8 |
| 1 | 7 (84) | 6 (72) | 3/8 |
| 1-1/4 | 7 (84) | 7 (84) | 3/8 |
| 1-1/2 | 9 (108) | 8 (96) | 3/8 |
| 2 | 10 (120) | 8 (96) | 3/8 |
| 2-1/2 | 11 (132) | 9 (108) | 1/2 |
| 3 | 12 (144) | 10 (120) | 1/2 |
| 3-1/2 | 13 (156) | 11 (132) | 1/2 |
| 4 | 14 (168) | 12 (144) | 5/8 (1/2 for copper) |
| 5 | 16 (192) | 13 (156) | 5/8 (1/2 for copper) |
| 6 | 17 (204) | 14 (168) | 3/4 (5/8 for copper) |
| 8 | 19 (228) | 16 (192) | 7/8 (3/4 for copper) |
| 10 | 22 (264) | 18 (216) | 7/8 (3/4 for copper) |
| 12 | 23 (276) | 19 (228) | 7/8 (3/4 for copper) |

a. Support vertical steel pipe and copper tube at each floor level.
b. Rod diameter may be reduced one (1) size for double-rod hangers, with three eights (3/8) inch minimum rods.

2. Sanitary and Storm Water Drain Piping Above Ground:

a. Support pipe and tubing in accordance with manufacturer's recommendations.
b. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

1) NPS 1-1/2 and NPS 2: Sixty (60) inches with three eights (3/8) inch rod.
2) NPS 3: Sixty (60) inches with one half (1/2) inch rod.
3) NPS 4 and NPS 5: Sixty (60) inches with five eights (5/8) inch rod.
4) NPS 6 and NPS 8: Sixty (60) inches with three quarters (3/4) inch rod.
5) NPS 10 and NPS 12: Sixty (60) inches with seven eights (7/8) inch rod.
6) Spacing for ten (10) foot lengths may be increased to ten (10) feet. Spacing for fittings is limited to sixty (60) inches.
7) Install supports for vertical cast-iron soil piping every fifteen (15) feet.
8) Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.3 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to one and one half (1-1/2) inches.

3.6 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Architectural Specification Sections "Exterior Painting" and "Interior Painting."

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 220529

# SECTION 220553 – IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 22.

### 1.2 SUMMARY

A. This section includes the requirements for identification of piping and equipment in the building using the following:

Equipment labels.
1. Warning signs and labels.
2. Pipe system labels.
3. Stencils.
4. Valve tags and schedules.
5. Ceiling tags
6. Laminate signs
7. Warning tags.

B. All plumbing equipment, systems, piping, shall be identified

### 1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1. Samples: For color, letter style, and graphic representation required for each identification material and device.
2. Data: Installation details, material descriptions, dimensions of individual components for each type tag and sign.
3. Equipment Label Schedule: Submit a sample equipment label schedule for each plumbing system. Include the equipment tag designation, name and location in an “xl” file format.
4. Valve Tag Schedule: Submit a sample valve tag schedule for each plumbing system. Include the valve tag designation, name and location in an “xl” file format.

### 1.4 CLOSEOUT SUBMITTALS

A. Operation & Maintenance Manual: Include a copy of the approved submittal for each product and material along with any applicable maintenance data in the project operation and maintenance manual.

B. Equipment Label Schedule: Include a complete equipment label schedule for each plumbing system. Include equipment tag designation, name and location, the operation and maintenance manual, in an "xl" electronic file format.

C. Valve Tag Schedules: Include a complete valve tag numbering schedule for each plumbing system. Include the system identification, valve number and location, in the operation and maintenance manual, in an "xl" electronic file format.

1.5 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

1.6 WARRANTY/GUARANTEE

A. See Division 22, Specification Section "Basic Mechanical Requirements – Plumbing" for warranty and guarantee requirements.

**PART 2 - PRODUCTS**

2.1 GENERAL PRODUCT REQUIREMENTS

A. Labels, Signs and Tags: All labels, signs and tags shall conform to ANSI/OSHA requirements for letter/color combinations.

B. Basis of Design: The basis of design shall be mechanical identifications materials manufactured by the Seton Name Plate Corporation as follows:

1. Equipment Labels – Style M4562 – M4565
2. Warning Signs – Style M4562 – M4565
3. Plumbing Pipe Labels – Size 8SM - 32
4. Valve Tags – Style 374

C. Other Acceptable Manufacturers: Subject to compliance with requirements, provide mechanical identifications materials from one (1) of the following:

1. Brady (Wilt.) Co. Singmark Division.
2. Industrial Safety Supply Co., Inc.

2.2 EQUIPMENT LABELS

A. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, one eighth (1/8) inch thick, and having predrilled holes for attachment hardware.
2. Minimum Label Size: Length and width vary for required label content, but not less than two and one half (2-1/2) inches by three quarter (3/4) inches.
3. Minimum Letter Size: One quarter (1/4) inch for name of units if viewing distance is less than twenty four (24) inches, one half (1/2) inch for viewing distances up to seventy two (72) inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two thirds (2/3) to three fourths (3/4) the size of principal lettering.
4. Fasteners: Self tapping stainless steel screws, except contact type permanent adhesive where screws cannot or should not penetrate the substrate.
5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's label as indicated on the construction documents.

C. Equipment Label Schedule:

2.3 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving one eighth (1/8) inch thick, and having predrilled holes for attachment hardware.

B. Minimum Label Size: Length and width vary for required label content, but not less than two and one half (2-1/2) inch by three quarter (3/4) inch.

C. Minimum Letter Size: One quarter (1/4) inch for name of units if viewing distance is less than twenty four (24) inches, one half (1/2) inch for viewing distances up to seventy two (72) inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two thirds (2/3) to three fourths (3/4) the size of principal lettering.

D. Fasteners: Self tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.

E. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

F. Label Content: Include caution and warning information, plus emergency notification instructions.

2.4 PLUMBING PIPE SYSTEM LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction according to ASME A13.1.

1. Do not use pipe labels or plastic tapes for bare pipes conveying fluids at temperatures of 125°F (52°C) or higher

B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover or cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

1. Small Pipes: For external diameters less than six (6) inches (including insulation if any), provide full-band pipe markers, extending 360 degrees around pipe at each location, fastened by one of the following methods:

a. Snap-on application of pre-tensioned semi-rigid plastic pipe marker.
b. Adhesive lap joint in pipe marker overlap.
c. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than three quarter (3/4) inch wide; full circle at both ends of pipe marker, tape lapped one and one half (1-1/2) inches.

2. Large Pipes: For external diameters of six (6) inches and larger (including insulation if any), provide either full-band or strip-type pipe markers, but not narrower than three (3) times letter height (and of required length), fastened by one of the following methods:

a. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than one and one half (1-1/2) inches wide; full circle at both ends of pipe marker, tape lapped three (3) inches.
b. Strapped-to-pipe (or insulation) application of semi-rigid type, with manufacturer's standard stainless steel bands.

C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

D. Pipe Label Contents: Pipe label contents shall comply with the following:

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: At least one and one half (1-1/2) inches high.
3. Label Designation and Colors: See chart on the next page.

| PLUMBING SERVICE DESIGNATION | LABEL DISIGNATION | FIELD/LETTER COLOR |
|---|---|---|
| Sanitary Waste | Same as Service Designation | Green / White |
| Sanitary Vent | Same as Service Designation | Green / White |
| Domestic Cold Water | Same as Service Designation | Blue / White |
| Domestic Hot Water | Same as Service Designation | Blue / White |
| A/C Condensate Drain | Same as Service Designation | Green / White |

2.5 STENCILS

A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; and minimum letter height of three quarter (3/4) inch for access panel and door labels, equipment labels, and similar operational instructions.

1. Stencil Material Fiberboard or metal.
2. Stencil Paint: Exterior, gloss, acrylic enamel black unless otherwise indicated. Paint may be in pressurized spray-can form.
3. Identification Paint: Exterior, acrylic enamel in colors according to ASME A13.1 unless otherwise indicated.

2.6 VALVE TAGS AND SCHEDULE

A. General: Valve tags and schedule are required to identify what systems the valves are installed in, where the valves are located and what duty the valves perform. Valve duty usually includes the following:

1. Shut off duty for a room, equipment and/or a floor.
2. Combination balancing/shut off duty.
3. Riser isolation duty.
4. Drain valves.
5. Control valves.
6. Shut off duty for back flow preventer.

B. Valve Tags:

1. Description: Stamped or engraved with one quarter (1/4) inch letters for piping system abbreviation and one half (1/2) inch numbers with:

a. Brass Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
b. Fasteners: Brass wire-link chain

2. Plastic Laminate Valve Tags: Provide manufacturer's standard three thirty second (3/32) inch thick engraved plastic laminate valve tags, with piping system

abbreviation in one quarter (1/4) inch high letters and sequenced valve numbers one half (1/2) inch high, and with five thirty second (5/32) inch hole for fastener.

a. Provide One and one half (1-1/2) inch sq. black tags with white lettering, except as otherwise indicated.
b. Provide size, shape and color combination as specified or scheduled for each piping system.

3. Plastic Valve Tags: Provide manufacturer's standard solid plastic valve tags with printed enamel lettering, with piping system abbreviation in approximately three sixteenth (3/16) inch high letters and sequenced valve numbers approximately three eights (3/8) inches high, and with five thirty second (5/32) inch hole for fastener.

a. Provide one and one eighth (1-1/8) inch sq. white tags with black lettering.
b. Provide size, shape and color combination as specified or scheduled for each piping system.
c. Valve Tag Fasteners: Provide manufacturer's standard solid brass chain (wire link or beaded type), or solid brass S-hooks of the sizes required for proper attachment of tags to valves, and manufactured specifically for that purpose.

4. Valve Tag Data: See chart on the next page:

| PLUMBING VALVE SERVICE | VALVE TAG DISIGNATION |
|---|---|
| Domestic Cold Water Service | DCWS – # |
| Domestic Cold Water Service – BFP | DCWBFP – # |
| Domestic Cold Water | DCW – # |
| Domestic Hot Water | DHW – # |

C. Valve Schedules: Provide a valve schedule in an “xl” file format for each Plumbing piping system. File shall include the valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room, space, equipment, pipe riser), and valve duty. Also mark valves for emergency shutoff and similar special uses as required by the project.

1. Numbering System: Valves shall be in numerical order starting with one (1) for each plumbing system.

2.7 CEILING MARKERS

A. Ceiling Grid and Access Panel Markers: Provide Kroy type clear adhesive printed labels with three sixteenth (3/16) inch high letters to identify the location and type of concealed components.

B. Ceiling Marker Data: For Plumbing printed data shall be as follows:

| ITEM | SERVICE | LABEL |
|---|---|---|
| LP Drain | Low Point Drain | PL Valve – LPD – * |
| PRD Valve – DCW | Pressure Reducing Valve | PL Valve – PRDV – DCW |
| PRD Valve – DHW | Pressure Reducing Valve | PL Valve – PRDV – DHW |
| PRD Valve – LCW | Pressure Reducing Valve | PL Valve – PRDV – LCW |
| PRD Valve – LHW | Pressure Reducing Valve | PL Valve – PRDV – LHW |
| San Cleanout | Sanitary Drain Cleanout | PL – Cleanout – SAN |

* System ID: Domestic Cold Water (DCW), Domestic Hot Water (DHW)

2.8 ENGRAVED PLASTIC LAMINATE SIGNS

A. General: Provide engraving stock melamine plastic laminate, complying with FS L-P-387, in the sizes and thicknesses indicated, engraved with engraver's standard letter style of the sizes and wording indicated, black with white core (letter color) except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.

B. Thickness: One eighth (1/8) inch, except as otherwise indicated.

C. Fasteners: Self tapping stainless steel screws, except contact type permanent adhesive where screws cannot or should not penetrate the substrate.

D. Nomenclature: Include the following, matching terminology on schedules as closely as possible.

E. Size: Provide approximate two and one half (2-1/2) inch x four (4) inch markers for control devices, dampers, and valves; and four and one half (4-1/2) inch x six (6) inches for equipment.

2.9 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.

1. Size: Three (3) inches by five and one quarter (5-1/4) inches minimum.
2. Fasteners: Self tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.
3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."

4. Color: Yellow background with black lettering.

**PART 3 - EXECUTION**

3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

A. Retain first paragraph below to identify piping systems by color-coded painting. Labels will still be required to identify service, pipe size, and flow direction.

B. Piping Color-Coding: Painting of piping is specified in Architectural Specification Section "Interior Painting."

C. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels with painted, color-coded bands or rectangles on each piping system.

1. Identification Paint: Use for contrasting background.
2. Stencil Paint: Use for pipe marking.

D. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, and cable pull areas; and exterior exposed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of fifty (50) feet along each run. Reduce intervals to twenty five (25) feet in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

E. Pipe Label Color Schedule:

3.4 VALVE TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and similar roughing-in connections of end-use fixtures and units.

3.5 VALVE TAG SCHEDULE

A. Include the valve schedule file in the electronic operation and maintenance manual.

3.6 WARNING TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

3.7 CEILING MARKERS

A. Location: Install each ceiling marker label and a dot on the surface of the ceiling grid 'T' bar and/or on the frame of an access door.

3.8 ADJUSTING AND CLEANING

A. Adjusting: Relocate any mechanical identification device which has become visually blocked by work of this division or other divisions.

B. Cleaning: Clean face of identification devices.

END OF SECTION 220553

# SECTION 220700 – INSULATION FOR PLUMBING PIPING AND EQUIPMENT

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 22.

### 1.2 SUMMARY

A. This section includes the requirements for insulating plumbing piping and equipment for the following:

1. Flexible elastomeric insulation.
2. Mineral fiber blanket insulation.
3. Mineral fiber preformed pipe insulation.
4. Insulating cement.
5. Achieves.
6. Mastics.
7. Lagging achieves.
8. Sealants.
9. Factory jackets.
10. Field cloths.
11. Field jackets.
12. Tapes.
13. Securements.
14. Protective shields.

### 1.3 ACTION SUBMITTALS

A. Product Data: For each specified product include:

1. Product Data: Product data for each type of mechanical insulation identifying manufacturer, k-value, thickness, and accessories. Include mastics, adhesives, jacketing, covers, canvas materials, vapor barrier material, etc.
2. Samples: Samples of each type of insulation and jacket. Identify each sample describing product and intended use. Submit the following sizes of sample materials:
   a. Board and Block Insulation: twelve (12) inches square section.
   b. Pre-Formed Pipe Insulation: twelve (12) inches long, two (2) inch NPS

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

1. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.
2. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation & Maintenance Manual: Include a copy of each approved submittal along with any applicable maintenance data in the project operation and maintenance manual.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of twenty five (25) or less, and smoke-developed index of fifty (50) or less.
2. Insulation Installed Outdoors: Flame-spread index of seventy five (75) or less, and smoke-developed index of one hundred fifty (150) or less.

C. Comply with the following applicable standards and other requirements specified for miscellaneous components:

1. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.8 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Plumbing Specification Section "Hangers and Supports for Plumbing Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.9 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

1.10 WARRANTY/GUARANTEE

A. See Division 22 Specification Section “Basic Mechanical Requirements – Plumbing” for warranty and guarantee requirements.

**PART 2 - PRODUCTS**

2.1 GENERAL PRODUCT REQUIREMENTS

A. Equipment Design and Selection: Insulation and accessories shall be designed and selected, for the intended use, in accordance with the details on the drawings and the requirements of this specification.

B. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. Fiberglass, Fiber Board and Cellular Insulation: Subject to compliance with requirements, provide products by one (1) of the following:

a. Owings Corning Inc.
b. John Manville
c. Knauf Inc.

d. Pittsburgh Corning Corporation; Foamglas.

2. Elastromeric Insulation: Subject to compliance with requirements, provide products by one (1) of the following:

a. Armstrong.
b. Armcell
c. Knauf Inc.

3. Adhesives, Mastics, and Sealants: Provide adhesives, mastics and sealant products recommended by the insulation manufacturer or by one (1) of the following:

a. Foster Brand.
b. Fueller Company.
c. Eagle Bridge.

2.2 INSULATION MATERIALS

A. Comply with requirements in "Piping and Equipment Insulation Schedule.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

2.3 FLEXIBLE ELASTOMERIC INSULATION

A. Closed-cell, with smooth skin on both sides. Comply with ASTM C 534, TYPE I for tubular materials.

2.4 MINERAL-FIBER, PREFORMED PIPE INSULATION

A. Type I, 850°F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.5 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.

1. Products: Subject to compliance with requirements, provide one (1) of the following:

   a. Ramco Insulation, Inc.; Super-Stik.

2. Thermal Conductivity: 1.2 average maximum at 400ºF mean temperature.
3. Compressive Strength: 100 psi at 5% deformation.

B. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Ramco Insulation, Inc.; Ramcote 1200 and Quik-Cote.

C. ADHESIVES Thermal Conductivity: 1.0 average maximum at 500ºF mean temperature.

1. Compressive Strength: 10 psi at 5% deformation.

2.6 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

E. PVC Jacket Adhesive: Compatible with PVC jacket.

1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.7 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.

1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
2. Service Temperature Range: -20°F to +180°F.
3. Solids Content: ASTM D 1644, 58% by volume and 70% by weight.
4. Color: Aluminum.

C. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below-ambient services.

1. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 35-mil dry film thickness.
2. Service Temperature Range: 0°F to 180°F.
3. Solids Content: ASTM D 1644, 44% by volume and 62% by weight.
4. Color: White.

D. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below-ambient services..

1. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
2. Service Temperature Range: -50°F to +220°F.
3. Solids Content: ASTM D 1644, 33% by volume and 46% by weight.
4. Color: White.

E. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.

1. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
2. Service Temperature Range: -20°F to +180°F.
3. Solids Content: 60% by volume and 66% by weight.
4. Color: White.

2.8 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C, Class I, Grade A, and shall be compatible with insulation materials, jackets, and substrates.

1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
3. Service Temperature Range: 0°F to 180°F.
4. Color: White.

2.9 SEALANTS

A. Joint Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Permanently flexible, elastomeric sealant.
3. Service Temperature Range: -100°F to +300°F.
4. Color: White or gray.
5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. ASJ Flashing Sealants, and Vinyl, and PVC Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: -40°F to +250°F.
4. Color: White.
5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.10 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.

2.11 FIELD-APPLIED CLOTHS

A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd.

2.12 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Adhesive: As recommended by jacket material manufacturer.
2. Color: White.
3. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

a. Shapes: 45 and 90 degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

2.13 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Width: Four (4) inch.
2. Thickness: 11.5 mils.
3. Adhesion: 90 ounces force/inch in width.
4. Elongation: 2%.
5. Tensile Strength: 40 lbf/inch in width.
6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

1. Width: Two (2) inches.
2. Thickness: 6 mils.
3. Adhesion: 64 ounces force/inch in width.
4. Elongation: 500%.
5. Tensile Strength: 18 lbf/inch in width.

2.14 SECUREMENTS

A. Bands:

1. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 0.015 inch thick, one half (1/2) inch wide
2. Aluminum: ASTM B 209 (ASTM B 209M with wing seal.), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch (0.51 mm) thick, one half (1/2) inch wide with wing seal.

B. Staples: Outward-clinching insulation staples, nominal three quarters (3/4) inch wide, stainless steel or Monel.

C. Wire: 0.080-inch nickel-copper alloy or 0.062-inch 1.6 soft-annealed, galvanized steel.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. C & F Wire.

2.15 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers,:

1. Description: Manufactured plastic wraps for covering plumbing hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that applies to insulation.

C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with three (3) inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced four (4) inches on center.
3. Overlap jacket longitudinal seams at least one and one half (1-1/2) inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at two (2) inches on center.

a. For below-ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75% of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least four (4) inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. Items Not Insulated: Unless otherwise indicated, do not apply insulation to the following systems, materials, and equipment.

1. Flexible connectors for pipes.
2. Vibration control devices.
3. Testing laboratory labels and stamps.
4. Nameplates and data plates.
5. Insulated access panels and doors in air distribution systems.
6. Fire protection piping systems.
7. Sanitary drainage and vent piping.
8. Drainage piping located in crawl spaces, unless indicated otherwise.
9. Chrome-plated pipes and fittings, except for plumbing fixtures for the disabled.
10. Piping specialties including air chambers, unions, strainers, check valves, plug valves, and flow regulators.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least two (2) inches below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

1. Comply with requirements in Architectural Specification Section "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

E. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Architectural Specification Section "Penetration Firestopping."

3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two (2) times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.

5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two (2) times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two (2) times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two (2) times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two (2) part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least two (2) inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover

assembly with insulating cement applied in two (2) coats. After first coat is dry, apply and trowel second coat to a smooth finish.

5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

## 3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturers recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturers recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

## 3.7 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward clinched staples at six (6) inches on center.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least one (1) inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

## 3.8 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with two (2) inch overlap at seams and joints.
2. Embed glass cloth between two 0.062 inch thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where PVC jackets are indicated, install with one (1)-inch overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

3.9 FINISHES

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Architectural Specification Sections "Exterior Painting" and ”Interior Painting."

1. Flat Acrylic Finish: Two (2) finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two (2) coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

3.10 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations

of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.11 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

3.12 INDOOR PIPING INSULATION SCHEDULE

| **INSULATION SCHEDULE - PIPING SYSTEMS** | | | | | | |
|---|---|---|---|---|---|---|
| **Pipe System** | **Pipe Size in Inches (NPS)** | **Materials** | **Thickness in Inches** | **Vapor Barrier Required** | **Field Applied Jacket-MER** | **Field Applied Jacket NON-MER** |
| Sanitary Drains and Traps Exposed at Fix-tures for Disabled | 1/2 to 1 1/2 | Flexible Elastomeric | 1/2 | Yes | None | None |
| Concealed Interior Domestic Water-40ºF - 110ºF | 1/2 to 1, Branch Run outs | Fiberglass<br>Flexible Elastomeric | 1/2<br>1/2 | Yes<br>Yes | N /A<br>N / A | None<br>None |
| | 1/2 to 1 1/2 | Fiberglass | 1 | Yes | N / A | None |
| | 2 to 36 | Fiberglass | 1 1/2 | Yes | N / A | None |
| Exposed Interior Domestic Water Pip-ing - 40ºF - 110ºF | 1/2 to 1, Branch Run - outs | Fiberglass<br>Flexible Elastomeric | 1/2<br>1/2 | Y<br>Yes | Glass Cloth | PVC<br>PVC |
| | 1/ 2 to 1 1/2 | Fiberglass | 1 | Yes | Glass Cloth | PVC |
| | 2 to 36 | Fiberglass | 1 1/2 | Yes | N / A | PVC |

3.13 T INSULATION SCHDULE

END OF SECTION 220700

**SECTION 220800 – COMMISSIONING PLUMBING SYSTEMS**
**PART 1 - GENERAL**

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 22.

B. The OPR and BOD documentation are included by reference for information only.

1.2 SUMMARY

A. This section includes the requirements for commissioning the plumbing systems, assemblies and equipment.

1.3 DESCRIPTION

A. The following equipment and/or accessories shall be commissioned as part of this project:

1. Domestic hot water heating equipment
2. Safety equipment
3. Interface connections with the BAS.

1.4 ACTION SUBMITTALS

A. Refer to Division 01 Specification Section “COMMISSIONING” for CxA’s role.

B. Refer to Division 01 Specification Section “SUBMITTAL PROCEDURES” for specific requirements.

C. Refer to Division 01 Specification Section “COMMISSIONING” for additional submittal requirements related to submittals of equipment to be commissioned and Cx specific submittals.

1.5 COORDINATION

A. Refer to Division 01 Specification Section “COMMISSIONING” for requirements pertaining to coordination during the commissioning process.

1.6 GENERAL DOCUMENTATION

A. With assistance from the installing contractors, the CxA will prepare Pre-Functional Checklists for all commissioned components, equipment, and systems.

1.7 WARRANTY/GUARENTEE

A. See Division 22, Specification Section "Basic Mechanical Requirements – Plumbing" for warranty and guarantee requirements.

## PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

A. Refer to Division 01 Specification Section "COMMISSIONING" for requirements pertaining to testing equipment.

## PART 3 - EXECUTION

3.1 TESTING PREPARATION

A. Certify in writing to the CxA that plumbing systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.

B. Place systems, subsystems, and equipment into operating mode to be tested (e.g. for pumps, normal shutdown, normal auto position, normal manual position, emergency power, and alarm conditions).

C. Inspect and verify the position of each device and interlock identified on checklists.

D. Check safety cutouts, alarms, and interlocks during mode of operation.

E. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

3.2 GENERAL TESTING REQUIREMENTS

A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.

B. 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.

C. The CxA along with the plumbing contractor shall prepare detailed testing plans, procedures, and checklists for applicable plumbing systems, subsystems, and equipment.

D. Tests will be performed using design conditions whenever possible.

3.3 PLUMBING SYSTEMS, SUBSYSTEMS, AND EQUIPMENT TESTING PROCEDURES

A. Procedures: Where applicable follow manufacturer's written procedures. If no procedures are prescribed by the manufacturer, proceed as follows:

1. Plumbing Piping Distribution Systems: Includes domestic water piping.

    a. Verify that all valves and accessories have been installed correctly, are accessible and operate as intended.
    b. Verify that specified tests of piping are complete.

2. Plumbing Equipment: Includes backflow preventers, hot water heating equipment.

    a. Verify that all equipment has been installed in accordance with the manufactures recommendations and all equipment can be easily accessed for maintenance.
    b. Verify that all valves, trim, fittings, controls, and accessories have been installed correctly and operates as intended.
    c. Verify that all equipment test, training, and startup procedures have been completed per the specifications.
    d. Verify that all required interfaces with the BAS have been installed correctly and operates as intended.
    e. Operate equipment as intended to ensure the design conditions can be obtained.

END OF SECTION 220800

# SECTION 221100 – DOMESTIC WATER PIPING SYSTEMS & SPECIALITIES

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 22.

### 1.2 SUMMARY

A. This section includes the requirements for domestic and/or laboratory water piping and specialties above ground within the building, and water service piping below the floor slab or underground to five (5) feet outside the building, and includes the following**:**

1. Copper tubing and fittings.
2. Ductile iron pipe and fittings.
3. Gaskets.
4. Transition fittings.
5. Dielectric fittings.
6. Vacuum breakers
7. Backflow preventers.
8. Outlet boxes.
9. Hose bibbs.
10. Wall hydrants.
11. Water-hammer arresters.
12. Air vents.
13. Trap-seal primer valves and systems.
14. Flexible connectors.
15. Water meters.

### 1.3 SUBMITTALS

A. Action Submittals:

1. Product Data: For each specified product, include manufacturers cut sheets, dimensional data, performance data, and warranty information.

### 1.4 INFORMATIONAL SUBMITTALS

A. System purging and disinfecting activities report.

B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation & Maintenance Manual: Include a copy of each approved submittal along with any applicable maintenance data in the project operation and maintenance manual.

1.6 PERFORMANCE REQUIREMENTS

A. Compatibility: Products shall be suitable for piping service fluids, materials, working pressures, and temperatures.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: The installer shall be a qualified licensed installer within the jurisdiction and familiar with the installation of the pipe and fittings specified herein for each piping system.

B. Compliance: Potable-water piping and components shall comply with NSF 14 and NSF 61.

C. Source Limitations: Obtain pipe and fittings from the same manufacturer for each pipe system.

1.8 FIELD CONDITIONS

A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:

1. Notify Construction Manager no fewer than five (5) days in advance of proposed interruption of water service.
2. Do not interrupt water service without Construction Manager's written permission.

1.9 WARRANTY/GUARENTEE

A. See Division 22, Specification Section “Basic Mechanical Requirements – Plumbing” for warranty and guarantee requirements.

**PART 2 - PRODUCTS**

2.1 GENERAL PRODUCT REQUIREMENTS

A. Material Design and Selection: Domestic and Laboratory water pipe, fittings, and specialties shall be designed and selected, for the intended use, in accordance with the sizes on the drawings and the requirements of this specification.

B. Acceptable Manufacturers: Acceptable manufacturers shall be as follows:

1. Ductile Iron Piping Systems: All ductile iron pipe and fittings shall be by one (1) manufacturer.

   a. American Cast Iron Pipe Company.
   b. US Pipe Company.
   c. Atlantic States Cast Iron Pipe Company.

2. Copper Tube Piping Systems:

   a. Solder Joint Copper Tube and Fittings: All copper tube and/or fittings for solder joint application shall be by one (1) manufacturer.

      1) Mueller Industries

   b. Press Type Copper Piping Systems: The basis of design is Viega ProPress copper piping system. Other acceptable manufacturers are:

      1) Nibco Inc.
      2) Elkhart Products Corporation – Apollo XPress.

3. Dielectric Fittings:

   a. Unions: Watts, Zurn and Capitol Manufacturing Company.
   b. Flanges: Watts, Zurn and Capitol Manufacturing Company.
   c. Insulating Kits: Pipeline Seal and Insulator Company, Calpico, Inc.
   d. Nipples: Victaulic, Precision Plumbing Products, Inc. and Elster Perfection

4. Vacuum Breakers: Watts, or Zurn.

5. Backflow Preventers: Watts, or Zurn.

6. Outlet Boxes: Oatey, Acorn Engineering Company or LSP Products Group Inc.

7. Wall Hydrants and Hose Bibbs: Josam or Zurn.

8. Water Hammer Arresters: Jay R. Smith, AMTROL, Inc., or Ancon.

9. Trap Primer Devices: Sloan, E&S Primer Valve, Zurn or Josam.

10. Flexible Connectors: Metraflex Corporation or approved equal

2.2 DOMESTIC WATER PIPE MATERIAL APPLICATION

A. General Application: All pipe, fittings and joint methods shall be as specified below. For this application, Domestic Water Piping Systems are defined as follows:

1. Building Water Service Piping System: Cold Water piping from the meter vault to the building and up through the floor slab.
2. Domestic (Potable) Water Piping Systems: Includes Cold Water, Hot Water, Piping serving non-laboratory areas of the building or project area.

B. Domestic Water Pipe Material Application Schedule:

| Pipe System | Pipe Material | Fitting Material | Joint Method |
|---|---|---|---|
| Building Water Service to 5 feet beyond building underground. | Copper Tube: ASTM B88, Type 'K', Seamless, Water Tube, hard drawn temper. | 1 inch to 2-1/2 inch, Copper Tube: ASTME B16.22, wrought copper or copper alloy solder joint, 150 lb. | ASTM B32, alloy Sb5 (95 percent tin, and 5 percent antimony), with 0.2 percent maximum lead content. ASTM B813 water flushable flux. |
| Building Water Service to 5 feet beyond building underground. | Ductile Iron: AWWA C151/A21.15 or AWWA C104 cement motor lining. | Piping 3 inch and larger: Ductile Iron: AWWA C110 or AWWA C153/A21.53 with AWWA C104 cement motor lining. | Push on or mechanical joints and gaskets: AWWA C111/A21.11. |
| Domestic Cold, Hot, piping, Above Ground within the building | Copper Tube: ASTM B88, Type 'L', Seamless, Water Tube, hard drawn temper. | 1/2 inch to 2 inch, Copper Tube: ASTME B16.22, wrought copper or copper alloy solder joint, 150 lb. | ASTM B32, alloy Sb5 (95 percent tin, and 5 percent antimony), with 0.2 percent maximum lead content. ASTM B813 water flushable flux. |
| | | 1/2 inch to 2 inch Viega ProPress copper fittings with EPDM seals. (Contractor Option) | Press connection with EPDM sealing element. (Contractor Option) |

2.3 DUCTILE-IRON PIPE FITTINGS

A. Mechanical-Joint, Ductile-Iron Pipe:

1. AWWA C151/A21.51, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.

2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

B. Standard-Pattern, Mechanical-Joint Fittings:

1. AWWA C110/A21.10, ductile or gray iron.
2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

C. Compact-Pattern, Mechanical-Joint Fittings:

1. AWWA C153/A21.53, ductile iron.
2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

## 2.4 COPPER TUBE MISCELLANEOUS FITTINGS

A. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.

B. Copper Unions:

1. MSS SP-123.
2. Cast-copper-alloy, hexagonal-stock body.
3. Ball-and-socket, metal-to-metal seating surfaces.
4. Solder-joint or threaded ends.

## 2.5 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials:

1. AWWA C110/A21.10, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
2. Full-face or ring type unless otherwise indicated.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys.

D. Flux: ASTM B 813, water flushable.

E. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

## 2.6 TRANSITION FITTINGS

A. General Requirements:

1. Same size as pipes to be joined.
2. Pressure rating at least equal to pipes to be joined.
3. End connections compatible with pipes to be joined.

B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

## 2.7 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:

1. Standard: ASSE 1079.
2. Pressure Rating: 125 psig minimum at 180°F.
3. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

1. Standard: ASSE 1079.
2. Factory-fabricated, bolted, companion-flange assembly.
3. Pressure Rating: 125 psig minimum at 180°F.
4. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:

1. Non-conducting materials for field assembly of companion flanges.
2. Pressure Rating: 150 psig.
3. Gasket: Neoprene or phenolic.
4. Bolt Sleeves: Phenolic or polyethylene.
5. Washers: Phenolic with steel backing washers.

E. Dielectric Nipples:

1. Standard: IAPMO PS 66.
2. Electroplated steel nipple complying with ASTM F 1545.
3. Pressure Rating and Temperature: 300 psig at 225°F.
4. End Connections: Male threaded or grooved.
5. Lining: Inert and noncorrosive, propylene.

## 2.8 VACUUM BREAKERS

A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:

1. Standard: ASSE 1001.
2. Size: NPS 1/4 to NPS 3, as required to match connected piping.
3. Body: Bronze.
4. Inlet and Outlet Connections: Threaded.
5. Finish: Rough bronze or Chrome plated.

B. Hose-Connection Vacuum Breakers:

1. Standard: ASSE 1011.
2. Body: Bronze, non-removable, with manual drain.
3. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
4. Finish: Chrome or nickel plated or Rough bronze.

## 2.9 BACKFLOW PREVENTERS

A. Reduced-Pressure Backflow Preventers:

1. Standard: ASSE 1013.
2. Operation: Continuous-pressure applications.
3. Pressure Loss: 12 psig maximum, through middle third of flow range.
4. Body: Bronze for NPS 2 and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved for NPS 2-1/2 and larger.
5. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
6. Configuration: Designed for horizontal, straight-through flow.
7. Accessories:

    a. Valves: See Valve section
    b. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

B. Double-Check, Backflow-Prevention Assemblies:

1. Standard: ASSE 1015.
2. Operation: Continuous-pressure applications unless otherwise indicated.
3. Pressure Loss: 5 psig maximum, through middle third of flow range.
4. Body: Bronze.
5. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
6. Configuration: Designed for horizontal, straight-through flow.

C. Hose Connection Backflow:

1. Standard: ASSE 1052.
2. Operation: Up to ten (10) foot head of water back pressure.
3. Inlet Size: NPS 1/2 or NPS 3/4.

4. Outlet Size: Garden-hose thread complying with ASME B1.20.7.
5. Capacity: At least three (3) gpm flow.

## 2.10 OUTLET BOXES

A. Icemaker Outlet Boxes:

1. Mounting: Recessed.
2. Material and Finish: Enameled-steel, epoxy-painted-steel, or plastic box and faceplate.
3. Faucet: Valved fitting complying with ASME A112.18.1. Include NPS 1/2 or smaller copper tube outlet.
4. Supply Shutoff Fitting: NPS 1/2 ball valve and NPS 1/2 copper, water tubing.

## 2.11 HOSE BIBBS

A. Hose Bibbs:

1. Standard: ASME A112.18.1 for sediment faucets.
2. Body Material: Bronze.
3. Seat: Bronze, replaceable.
4. Supply Connections: NPS 3/4 threaded or solder-joint inlet.
5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
6. Pressure Rating: 125 psig.
7. Vacuum Breaker: Integral non-removable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
8. Finish: Rough bronze.
9. Operation: Operating key.

## 2.12 WALL HYDRANTS

A. Non freeze Wall Hydrants:

1. Standard: ASME A112.21.3M for concealed outlet, self-draining wall hydrants.
2. Pressure Rating: 125 psig.
3. Operation: Loose key.
4. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
5. Inlet: NPS 3/4.
6. Outlet: Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
7. Box: Deep, flush mounted with cover.
8. Box and Cover Finish: Polished nickel bronze.
9. Outlet: Exposed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.

2.13 WATER HAMMER ARRESTERS

A. Water Hammer Arresters:

1. Standard: ASSE 1010 or PDI-WH 201.
2. Type: Metal bellows or Copper tube with piston.
3. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes 'A' through 'F'.

2.14 AIR VENTS

A. Bolted Construction Automatic Air Vents:

1. Body: Bronze.
2. Pressure Rating and Temperature: 125-psig minimum pressure rating at 140°F.
3. Float: Replaceable, corrosion-resistant metal.
4. Mechanism and Seat: Stainless steel.
5. Size: NPS 3/8 inch minimum inlet.
6. Inlet and Vent Outlet End Connections: Threaded.

B. Welded Construction Automatic Air Vents:

1. Body: Stainless steel.
2. Pressure Rating: 150 psig minimum pressure rating.
3. Float: Replaceable, corrosion-resistant metal.
4. Mechanism and Seat: Stainless steel.
5. Size: NPS 3/8 minimum inlet.
6. Inlet and Vent Outlet End Connections: Threaded.

2.15 TRAP PRIMER DEVICES AND SYSTEM

A. Trap Primer Device - Flush Valve Type:

1. Where applicable, priming lines may be connected to a Sloan F72-A1 trap primer

B. Trap Primer Device - Pressure Differential Valve Type:

1. Primers shall be E&S Primer Valves, Zurn, Josam or equal chrome plated with vandal-proof screws and with three eighth (3/8) inch water connections, as connected as to the prime the trap on a variation in water pressure in the mains. Take water connections from the nearest cold water line and provide the loose key stops. Set primers above floor level of the drains they serve. Primer valves behind walls shall be provided with access doors as specified hereinbefore.

C. Trap-Seal Primer Systems:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:

    a. Precision Plumbing Products.
    b. Zurn Industries, LLC.
    c. Watts.

2. Standard: ASSE 1044.
3. Piping: NPS 3/4, ASTM B 88, Type L; copper, water tubing.
4. Cabinet: Surface-mounted steel box with stainless-steel cover.
5. Electric Controls: 24-hour timer, solenoid valve, and manual switch for 120-V ac power.

    a. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

6. Vacuum Breaker: ASSE 1001.
7. Number Outlets: Eight.
8. Size Outlets: NPS 1/2.

## 2.16 FLEXIBLE CONNECTORS

A. Bronze-Hose Flexible Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.

B. Working-Pressure Rating: Minimum 200 psig.

C. End Connections NPS 2 and Smaller: Threaded copper pipe or plain-end copper tube.

D. End Connections NPS 2-1/2 and Larger: Flanged copper alloy.

E. Stainless-Steel-Hose Flexible Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.

1. Working-Pressure Rating: Minimum 200 psig.
2. End Connections NPS 2 and Smaller: Threaded steel-pipe nipple.
3. End Connections NPS 2-1/2 and Larger: Flanged steel nipple.

## 2.17 BUILDING SERVICE DOMESTIC WATER ENERGY METER

A. Provide building service domestic water energy meter where indicated on the construction documents. See Division 23 Specification Sections for the “Building Automation Systems” for meter requirements.

## PART 3 - EXECUTION

### 3.1 EARTHWORK

A. Comply with requirements in Division 31 Specification Section "Earth Moving" for excavating, trenching, and backfilling.

### 3.2 INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."

C. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.

D. Install domestic water piping level with 0.25% slope downward toward drain without pitch and plumb.

E. Install domestic water piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

F. Install domestic water piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

G. Install domestic water piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

H. Install domestic water piping to permit valve servicing.

I. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.

J. Install domestic water piping free of sags and bends.

K. Install fittings for changes in direction and branch connections.

L. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

M. Install thermometers on inlet and outlet piping from each water heater. Comply with requirements for thermometers in Division 22 Specification Section "Thermometers and Gauges for Plumbing Piping."

N. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 22 Specification Section "Sleeves, Sleeve Seals and Escutcheons for Plumbing Piping."

O. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 22 Specification Section "Sleeves, Sleeve Seals and Escutcheons for Plumbing Piping."

P. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 22 Specification Section "Sleeve, Sleeve Seals and Escutcheons for Plumbing Piping."

3.3 PIPE SPECIALTIES INSTALLATION

A. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.

1. Locate backflow preventers in same room as connected equipment or system.
2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe-to-floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are unacceptable for this application.
3. Do not install bypass piping around backflow preventers.

B. Where required install outlet boxes recessed in wall or surface mounted on wall. Install two (2) inch by four (4) inch fire-retardant-treated-wood blocking, wall reinforcement between studs. Comply with requirements for fire-retardant-treated-wood blocking in Architectural Specification Section "Rough Carpentry."

C. Set non-freeze, non-draining-type post hydrants in concrete or pavement.

D. Install water-hammer arresters in water piping according to PDI-WH 201.

E. Install air vents at high points of water piping. Install drain piping and discharge onto floor drain.

F. Install supply-type, trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1%, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.

G. Install drainage-type, trap-seal primer valves as lavatory trap with outlet piping pitched down toward drain trap a minimum of 1%, and connect to floor-drain body, trap, or inlet fitting.

H. Install trap-seal primer systems with outlet piping pitched down toward drain trap a minimum of 1%, and connect to floor-drain body, trap, or inlet fitting. Adjust system for proper flow.

3.4 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

D. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Brazed Joints" chapter.

E. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

F. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer.

G. Extruded-Tee Connections: Form tee in copper tube according to ASTM F 2014. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.

H. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.

I. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.5 TRANSITION FITTING INSTALLATION

A. Install transition couplings at joints of dissimilar piping.

B. Transition Fittings in Underground Domestic Water Piping:

1. Fittings for NPS 1-1/2 and Smaller: Fitting-type coupling.
2. Fittings for NPS 2 and Larger: Sleeve-type coupling.

3.6 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

3.7 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for seismic-restraint devices in Division 22 Specification Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Comply with requirements for pipe hanger, support products, and installation in Division 22 Specification Section "Hangers and Supports for Plumbing Piping and Equipment."

3.8 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.

C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:

1. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
2. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
3. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.9 IDENTIFICATION

A. Identify system components. Comply with requirements for identification materials and installation in Division 22 Specification Section "Identification for Plumbing Piping and Equipment."

3.10 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Piping Inspections:

    a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
    b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:

        1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.

        2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.

    c. Re-inspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for re-inspection.
    d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

B. Prepare test and inspection reports.

3.11 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.

    a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
    b. Adjust calibrated balancing valves to flows indicated.

5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.12 CLEANING

A. Clean and disinfect domestic and laboratory water piping systems as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:

a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
b. Fill and isolate system according to either of the following:

1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for twenty four (24) hours.

2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three (3) hours.
c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
d. Repeat procedures if biological examination shows contamination.
e. Submit water samples in sterile bottles to authorities having jurisdiction.

B. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.

C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.13 MISCELLANIOUS FITTINGS

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.

C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.

3.14 LEAK TEST PIPING SYSTEMS

A. See Division 22 Specification Section “Leak Test Plumbing Piping Systems” for testing requirements.

END OF SECTION 221100

# SECTION 221113 - FACILITY WATER DISTRIBUTION

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. This Section includes water-distribution piping and related components outside the building for water service.

B. Utility-furnished products include water meters that will be furnished to the site, ready for installation.

### 1.3 DEFINITIONS

A. DIP: Ductile Iron Pipe.

### 1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Coordination Drawings: For piping including relation to other services in same area, drawn to scale. Show piping and specialty sizes and valves, meter and specialty locations, and elevations.

C. Field quality-control test reports.

### 1.5 QUALITY ASSURANCE

A. Regulatory Requirements:

1. Comply with City of Baltimore standards for potable-water-service piping, including materials, installation, testing, disinfection and backflow prevention.

B. Piping materials shall bear label, stamp, or other markings of specified testing agency.

C. NSF Compliance:

1. Comply with NSF 61 for materials for water-service piping and specialties for domestic water.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.

B. Protect stored piping from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing inside.

1.7 PROJECT CONDITIONS

A. Interruption of Existing Water-Distribution Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water-distribution service according to requirements indicated:

1. Notify Architect and Owner no fewer than two days in advance of proposed interruption of service.
2. Do not proceed with interruption of water-distribution service without Owner's written permission.

**PART 2 - PRODUCTS**

2.1 DUCTILE-IRON PIPE AND FITTINGS

A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.

1. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
2. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

B. Flanges: ASME 16.1, Class 125, cast iron.

2.2 METER VAULT

A. Per Baltimore City Standard.

## PART 3 - EXECUTION

### 3.1 EARTHWORK

A. Refer to Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

### 3.2 PIPING APPLICATIONS

A. General: Use pipe, fittings, and joining methods for piping systems according to the following applications.

B. Transition couplings and special fittings with pressure ratings at least equal to piping pressure rating may be used, unless otherwise indicated.

C. Do not use flanges or unions for underground piping.

D. Flanges, unions, grooved-end-pipe couplings, and special fittings may be used, instead of joints indicated, on aboveground piping and piping in vaults.

E. Underground water-service piping NPS 3/4 to NPS 3 shall be the following:

1. Soft copper tube, ASTM B 88, Type K; wrought-copper, solder-joint fittings; and brazed joints.

F. Underground water-service piping NPS 4 to NPS 8 shall be the following:

1. Ductile-iron, mechanical-joint pipe; ductile-iron, mechanical-joint fittings; and mechanical joints.

### 3.3 PIPING INSTALLATION

A. Install ductile-iron, water-service piping according to AWWA C600 and AWWA M41.

1. Install PE corrosion-protection encasement according to ASTM A 674 or AWWA C105.

B. Bury piping with depth of cover over top at least 30 inches, with top at least 12 inches below level of maximum frost penetration, and according to the following:

1. In Loose Gravelly Soil and Rock: With at least 12 inches additional cover.

C. Extend water-service piping and connect to water-supply source and building-water-piping systems at outside face of building wall in locations and pipe sizes indicated.

1. Terminate water-service piping at building wall until building-water-piping systems are installed. Terminate piping with caps, plugs, or flanges as required for piping material. Make connections to building-water-piping systems when those systems are installed.

D. Sleeves are specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."

E. Mechanical sleeve seals are specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."

F. Install underground piping with restrained joints at horizontal and vertical changes in direction. Use restrained-joint piping, thrust blocks, anchors, tie-rods and clamps, and other supports.

G. See Division 22 Section "Domestic Water Piping" for potable-water piping inside the building.

## 3.4 JOINT CONSTRUCTION

A. See Division 2 Section "Piped Utilities - Basic Materials and Methods" for basic piping joint construction.

B. Make pipe joints according to the following:

1. Copper-Tubing, Pressure-Sealed Joints: Use proprietary crimping tool and procedure recommended by copper, pressure-seal-fitting manufacturer.
2. Ductile-Iron Piping, Gasketed Joints for Water-Service Piping: AWWA C600 and AWWA M41.

## 3.5 ANCHORAGE INSTALLATION

A. Anchorage, General: Install water-distribution piping with restrained joints. Anchorages and restrained-joint types that may be used include the following:

1. Concrete thrust blocks.
2. Locking mechanical joints.
3. Set-screw mechanical retainer glands.
4. Bolted flanged joints.
5. Heat-fused joints.
6. Pipe clamps and tie rods.

B. Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches. Include anchorages for the following piping systems:

1. Gasketed-Joint, Ductile-Iron, Water-Service Piping: According to AWWA C600.

C. Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

## 3.6 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. See Division 22 for piping connections to valves and equipment.

C. Connect water-distribution piping to existing water piping.

D. Connect water-distribution piping to interior domestic water piping.

## 3.7 FIELD QUALITY CONTROL

A. Piping Tests: Conduct piping tests before joints are covered and after concrete thrust blocks have hardened sufficiently. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water.

B. Hydrostatic Tests: Test at not less than one-and-one-half times working pressure for two hours.

1. Increase pressure in 50-psig increments and inspect each joint between increments. Hold at test pressure for 1 hour; decrease to 0 psig. Slowly increase again to test pressure and hold for 1 more hour. Maximum allowable leakage is 2 quarts per hour per 100 joints. Remake leaking joints with new materials and repeat test until leakage is within allowed limits.

C. Prepare reports of testing activities.

## 3.8 IDENTIFICATION

A. Install continuous underground detectable warning tape during backfilling of trench for underground water-distribution piping. Locate below finished grade, directly over piping. Underground warning tapes are specified in Division 31 Section "Earth Moving".

## 3.9 CLEANING

A. Clean and disinfect water-distribution piping as follows:

1. Purge new water-distribution piping systems and parts of existing systems that have been altered, extended, or repaired before use.
2. Use purging and disinfecting procedure, if method is not prescribed by Owner, use procedure described in NFPA 24 for flushing of piping. Flush piping system with clean, potable water until dirty water does not appear at points of outlet.
3. Use purging and disinfecting procedure, if method is not prescribed by authorities having jurisdiction, use procedure described in AWWA C651 or do as follows:

    a. Fill system or part of system with water/chlorine solution containing at least 50 ppm of chlorine; isolate and allow to stand for 24 hours.
    b. Drain system or part of system of previous solution and refill with water/chlorine solution containing at least 200 ppm of chlorine; isolate and allow to stand for 3 hours.
    c. After standing time, flush system with clean, potable water until no chlorine remains in water coming from system.
    d. Submit water samples in sterile bottles. Repeat procedure if biological examination shows evidence of contamination.

B. Prepare reports of purging and disinfecting activities.

END OF SECTION 221113

# SECTION 221313 - FACILITY SANITARY SEWERS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:

1. Pipe and fittings.
2. Cleanouts.
3. Manholes.

### 1.3 DEFINITIONS

A. HDPE: High-density Polyethylene

### 1.4 SUBMITTALS

A. Product Data: For each type of HDPE pipe and fitting, from manufacturer.

B. Shop Drawings: For manholes. Include plans, elevations, sections, details, and frames and covers.

C. Field quality-control reports.

### 1.5 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic manholes, pipe, and fittings in direct sunlight.

B. Protect pipe, pipe fittings, and seals from dirt and damage.

C. Handle manholes according to manufacturer's written rigging instructions.

1.6 PROJECT CONDITIONS

A. Interruption of Existing Sanitary Sewerage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Architect Owner no fewer than two days in advance of proposed interruption of service.
2. Do not proceed with interruption of service without Owner's written permission.

**PART 2 - PRODUCTS**

2.1 PVC PIPE AND FITTINGS

A. PVC Gravity Sewer Piping:

1. Pipe and Fittings: ASTM F 679, T-1 wall thickness, PVC gravity sewer pipe with bell-and-spigot ends and with integral ASTM F 477, elastomeric seals for gasketed joints.

2.2 MANHOLES

A. Standard Precast Concrete Manholes:

1. Description: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
2. Diameter: 48 inches minimum unless otherwise indicated.
3. Ballast: Increase thickness of precast concrete sections or add concrete to base section, as required to prevent flotation.
4. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section; with separate base slab or base section with integral floor.
5. Riser Sections: 4-inch minimum thickness, of length to provide depth indicated.
6. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated; with top of cone of size that matches grade rings.
7. Joint Sealant: ASTM C 990, bitumen or butyl rubber.
8. Resilient Pipe Connectors: ASTM C 923, cast or fitted into manhole walls, for each pipe connection.
9. Steps: ASTM A 615/A 615M, deformed, 1/2-inch steel reinforcing rods encased in ASTM D 4101, PP; wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals. Omit steps if total depth from floor of manhole to finished grade is less than 36 inches.

10. Adjusting Rings: Precast rubber grade adjustment ring (GNR Technologies Infra-Riser of Approved Equal). Use maximum of two rings, with level or sloped edge in thickness and diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.
11. Grade Rings: Reinforced-concrete or brick masonry rings, 6- to 9-inch total thickness, with diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope.

B. Manhole Frames and Covers:

1. Description: Ferrous; 24-inch ID by 7- to 9-inch riser, with 4-inch- minimum-width flange and 26-inch- diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "SANITARY SEWER."
2. Material: ASTM A 48, Class 30B cast iron unless otherwise indicated.

C. Manhole-Cover Inserts:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. FRW Industries; a Syneco Systems, Inc. company.
    b. Knutson Enterprises.
    c. L. F. Manufacturing, Inc.
    d. Parson Environmental Products, Inc.

2. Description: Manufactured, plastic form, of size to fit between manhole frame and cover and designed to prevent stormwater inflow. Include handle for removal and gasket for gastight sealing.
3. Type: Solid.

## 2.3 CLEANOUTS

A. PVC Cleanouts:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Canplas LLC.
    b. IPS Corporation.
    c. NDS.
    d. Plastic Oddities; a division of Diverse Corporate Technologies, Inc.
    e. Sioux Chief Manufacturing Company, Inc.

f. Zurn Light Commercial Products Operation; Zurn Plumbing Products Group.

2. Description: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

2.4 CONCRETE

A. General: Cast-in-place concrete complying with ACI 318, ACI 350/350R, and the following:

1. Cement: ASTM C 150, Type II.
2. Fine Aggregate: ASTM C 33, sand.
3. Coarse Aggregate: ASTM C 33, crushed gravel.
4. Water: Potable.

B. Portland Cement Design Mix: 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio.

1. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 deformed steel.

C. Manhole Channels and Benches: Field formed from concrete. Portland cement design mix, 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.

1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.

a. Invert Slope: 2 percent through manhole.

2. Benches: Concrete, sloped to drain into channel.

a. Slope: 8 percent.

**PART 3 - EXECUTION**

3.1 EARTHWORK

A. Refer to Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

## 3.2 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground sanitary sewer piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements.

C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.

D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

E. Install gravity-flow, nonpressure, drainage piping according to the following:

1. Install piping pitched down in direction of flow, at minimum slope of 2 percent unless otherwise indicated.
2. Install piping NPS 6 and larger with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place-concrete supports or anchors.
3. Install piping with 48-inch minimum cover, unless otherwise indicated..
4. Install PVC gravity sewer piping according to ASTM D 2321 and ASTM F 1668.

F. Clear interior of piping and manholes of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.

## 3.3 PIPE JOINT CONSTRUCTION

A. Join gravity-flow, nonpressure, drainage piping according to the following:

1. Join PVC gravity sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric-gasket joints.
2. Join dissimilar pipe materials with nonpressure-type, flexible or rigid couplings.

## 3.4 MANHOLE INSTALLATION

A. General: Install manholes complete with appurtenances and accessories indicated.

B. Install precast concrete manhole sections with sealants according to ASTM C 891.

C. Form continuous concrete channels and benches between inlets and outlet.

D. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 3 inches above finished surface elsewhere unless otherwise indicated.

E. Install manhole-cover inserts in frame and immediately below cover.

## 3.5 CLEANOUT INSTALLATION

A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts, and use cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.

B. Set cleanout frames and covers in earth in cast-in-place-concrete block, 18 by 18 by 12 inches deep. Set with tops 1 inch above surrounding grade.

C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

## 3.6 CONCRETE PLACEMENT

A. Place cast-in-place concrete according to ACI 318.

## 3.7 CONNECTIONS

A. Connect nonpressure, gravity-flow drainage piping to building's sanitary building drains specified in Division 22 Section "Sanitary Waste and Vent Piping."

B. Make connections to existing piping and underground manholes.

1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye fitting plus 6-inch overlap with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
2. Make branch connections from side into existing piping, NPS 4 to NPS 20. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.

3. Protect existing piping and manholes to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

## 3.8 IDENTIFICATION

A. Materials and their installation are specified in Division 2 Section "Earthwork." Arrange for installation of green warning tapes directly over piping and at outside edges of underground manholes.

1. Use detectable warning tape over nonferrous piping and over edges of underground manholes.

## 3.9 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.

1. Submit separate report for each system inspection.
2. Defects requiring correction include the following:

    a. Alignment: Less than full diameter of inside of pipe is visible between structures.
    b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
    c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
    d. Infiltration: Water leakage into piping.
    e. Exfiltration: Water leakage from or around piping.

3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
4. Reinspect and repeat procedure until results are satisfactory.

B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.

1. Do not enclose, cover, or put into service before inspection and approval.
2. Test completed piping systems according to requirements of authorities having jurisdiction.
3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
4. Submit separate report for each test.

C. Leaks and loss in test pressure constitute defects that must be repaired.

D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

3.10 CLEANING

A. Clean dirt and superfluous material from interior of piping. Flush with potable water.

END OF SECTION 221313

# SECTION 221316 – SANITARY, CHEMICAL, AND VENT PIPING SYSTEMS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 22.

### 1.2 SUMMARY

A. This section includes the requirements for sanitary, chemical and vent piping and specialties above ground within the building, and sanitary piping below the floor slab to five (5) feet outside the building, and includes the following**:**
   1. Cast iron hub and spigot pipe and fittings.
   2. Specialty pipe fittings.
   3. Floor drains.
   4. Backwater valves.
   5. Cleanouts.
   6. Drainage specialties.

### 1.3 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:

   1. Soil, Waste, and Vent Piping: Ten (10) foot head of water.

B. Seismic Performance: Soil, waste, and vent piping and support and installation shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

### 1.4 ACTION SUBMITTALS

A. Product Data: For each specified product, include manufacturers cut sheets, dimensional data, performance data, installation instructions, and warranty information.

B. LEED Submittals:

   1. Product Data for Credit IEQ 4.1: For solvent cements and adhesive primers, documentation including printed statement of VOC content.
   2. Laboratory Test Reports for Credit IEQ 4: For solvent cements and adhesive primers, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Shop Drawings: For drainage system. Include plans, elevations, sections, and details.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Include a copy of each approved submittal along with any applicable maintenance data in the project operation and maintenance manual.

1.6 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For waste and vent piping, accessories, and components, from manufacturer.

B. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

C. Detailed description of piping anchorage devices on which the certification is based and their installation requirements.

D. Field quality-control reports.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: The installer shall be a qualified licensed installer within the jurisdiction and familiar with the installation of the pipes and fittings specified herein for each piping system.

B. Material Labels: Piping materials shall bear label, stamp, or other markings of specified testing agency.

C. Compliance: Comply with NSF/ANSI 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping and "NSF-sewer" for plastic sewer piping.

D. Source Limitations: Obtain pipe and fittings from the same manufacturer for each pipe system.

1.8 PROJECT CONDITIONS

A. Interruption of Existing Sanitary Waste Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Owner no fewer than ten (10) days in advance of proposed interruption of sanitary waste service.
2. Do not proceed with interruption of sanitary waste service without Owner's written permission.

1.9 WARRANTY/GUARENTEE

A. See Division 22, Specification Section "Basic Mechanical Requirements – Plumbing" for warranty and guarantee requirements.

**PART 2 - PRODUCTS**

2.1 GENERAL PRODUCT REQUIREMENTS

A. Material Design and Selection: Sanitary, Chemical and Vent pipes, fittings, and specialties shall be designed and selected, for the intended use, in accordance with the sizes on the drawings and the requirements of this specification.

B. Acceptable Manufacturers:

1. Cast Iron Piping Systems: The basic of design is Charlotte Pipe. Other acceptable manufacturers are:

a. Tyler Pipe Company.

2. Floor Drains, Cleanouts: The basis of design is Zurn Plumbing Products. Other acceptable manufacturers are:

a. Josam Company
b. J.R. Smith Manufacturing Company
c. MIFAB Inc.

3. Specialty Pipe Fittings: The basis of design is Watts Plumbing Products. Other acceptable manufacturers are:

a. Wilkins.
b. Capitol Manufacturing Company
c. Fernco Inc.

2.2 SANITARY AND VENT PIPE APPLICATION

A. General Application: All pipe, fittings and joint methods shall be as specified below. The listed manufacturers, materials and model numbers below are the basis of design. For this application, Sanitary, Chemical and Vent Piping Systems are defined as follows:

1. Sanitary System: Includes Waste and Vent Piping serving non laboratory areas of the project and/or the building.

B. Sanitary and Vent Pipe Material Application Schedule:

1. See application schedule below:

| Pipe System | Pipe Material | Fitting Material | Joint Material |
|---|---|---|---|
| Sanitary and Vent Systems Below Grade to 5 feet beyond the building. | Cast Iron: Service Weight, Hub and Spigot, 2 inch – 15 inch, ASTM A74 | Cast Iron: Service Weight, Hub and Spigot, ASTM A74 | Hub and Spigot, Lead and Oakum joints or compression gaskets, ASTM C 564 |
| | All Cast Iron Soil Pipe and Fittings shall be marked with the Collective Trade Mark of the Cast Iron Soil Pipe Institute (CISPI) and listed by NSF International. | | |
| Non Laboratory Sanitary and Vent Systems above ground within the building | Cast Iron: Service Weight, No Hub, 2 inch – 10 inch C15P1-301. | Cast Iron: Service Weight, No Hub, C15P1-301 | Couplings: Heavy Duty Type 304 Stainless Steel, ASTM 564 neoprene gasket, 3 inch wide for piping less than 4 inch and 4 inch wide for piping 4 inch and larger. |

2.3 FLOOR DRAINS

A. Cast Iron Floor Drain - FD – 1:

1. Model: Zurn Z415
2. Standard: ASME A112.6.3.
3. Pattern: Floor Drain.
4. Body Material: Cast Iron.
5. Seepage Flange: Required.
6. Anchor Flange: Required.
7. Clamping Device: Required.
8. Outlet: Bottom, Threaded, Spigot or No Hub.
9. Backwater Valve: Not Required.
10. Coating – Interior and Exterior Exposed Surfaces: Acid resistant enamel.
11. Sediment Bucket: Not Required.
12. Top of Strainer Material: Nickle Bronze.
13. Top of Strainer Finish: Nickle Bronze.
14. Top Shape: Round.
15. Strainer Dimension: Eight (8) inches.
16. Top Loading Classification: Light Duty.
17. Funnel: Not Required.
18. Inlet Fitting: Gray Iron.
19. Trap Material: Cast Iron.
20. Trap Pattern: ‘P’ Trap.

21. Trap Feature: Trap primer connection.

2.4 CLEANOUTS

A. Exposed Metal Cleanouts:

1. ASME A112.36.2M, Cast-Iron Cleanouts with straight threads and gasket seal or taper threads for plug flashing flange and clamping ring, and a brass closure plug. Cleanouts for installation in floors not having membrane waterproofing may be furnished without clamping ring:
2. Cleanouts in concrete floors:

a. Basis-of-Design Product: Subject to compliance with requirements, provide Zurn Model No. Z-1400 style to suit floor finish with round scoriated top or comparable product by one of the following:

3. Cleanouts in Finished Floors:

a. Basis-of-Design Product: Subject to compliance with requirements, provide Zurn Model No. ZN-1400 style to suit floor finish with recessed top for tile or carpet, or comparable product.

2.5 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Open Drains:

1. Description: Shop or field fabricate from ASTM A 74, Service class, hub-andspigot, cast-iron, soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C 564, rubber gaskets.
2. Size: Same as connected waste piping with increaser fitting of size indicated.

B. Floor-Drain, Trap-Seal Primer Fittings:

1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
2. Size: Same as floor drain outlet with NPS 1/2 or 3/4 side inlet.

C. Air-Gap Fittings:

1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
2. Body: Bronze or cast iron.
3. Inlet: Opening in top of body.
4. Outlet: Larger than inlet.

5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

D. Sleeve Flashing Device:

1. Description: Manufactured, cast-iron fitting, with clamping device, that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 2 inches above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
2. Size: As required for close fit to riser or stack piping.

## PART 3 - EXECUTION

### 3.1 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Division 31 Specification Section "Earth Moving."

### 3.2 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of sanitary, chemical and vent piping systems. Install sanitary, chemical and vent piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install chemical and vent piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install chemical and vent piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install chemical and vent piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install chemical and vent piping to permit valve servicing.

F. Install chemical and vent piping at indicated slopes.

G. Install chemical and vent piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install chemical and vent piping to allow application of insulation.

J. Make changes in direction for sanitary, chemical and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if two (2) fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

K. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

L. Install sanitary, chemical and vent piping at the following minimum slopes unless otherwise indicated:

1. Building Sanitary Drain: 2% downward in direction of flow for piping NPS 3 and smaller; 1% downward in direction of flow for piping NPS 4 and larger.
2. Horizontal Sanitary Drainage Piping: 2% downward in direction of flow.
3. Vent Piping: 1% down toward vertical fixture vent or toward vent stack.

M. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

1. Install encasement on underground piping according to ASTM A 674 or AWWA C105/A 21.5.

N. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

O. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 22 Specification Section "Sleeves, Sleeve Seals and Escutcheons for Plumbing Piping."

P. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 22 Specification Section "Sleeves, Sleeve Seals and Escutcheons for Plumbing Piping."

Q. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 22 Specification Section "Sleeve, Sleeve Seals and Escutcheons for Plumbing Piping."

3.3 INSTALLATION

A. Assemble open drain fittings and install with top of hub one (1) inch above floor.

B. Install deep-seal traps on floor drains and other waste outlets, if indicated.

C. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.

1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
2. Size: Same as floor drain inlet.

D. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.

E. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

F. Plumbing Specialties:

1. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary drainage gravity-flow piping. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping.
2. Install drains in sanitary drainage gravity-flow piping.
3. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
4. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
5. Position floor drains for easy access and maintenance.
6. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:

    a. Radius, Thirty (30) Inches or Less: Equivalent to one (1) percent slope, but not less than one quarter (1/4) inch total depression.
    b. Radius, Thirty (30) to sixty (60) Inches: Equivalent to one (1) percent slope.
    c. Radius, Sixty (60) Inches or Larger: Equivalent to one (1) percent slope, but not greater than one (1) inch total depression.

7. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
8. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

3.4 JOINT CONSTRUCTION

A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum calked joints.

C. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

D. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.

3.5 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in OD's.
2. In Drainage Piping: Unshielded, nonpressure transition couplings.

3.6 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect drainage and vent piping to the following:

1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
5. Equipment: Connect drainage piping as indicated. Provide shutoff valve if indicated and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.

D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

E. Make connections according to the following unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.7 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Division 22 Specification Section "Identification for Plumbing Piping and Equipment."

3.8 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least twenty four (24) hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

3.9 CLEANING AND PROTECTION

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

3.10 CONNECTIONS

A. Install piping adjacent to equipment to allow service and maintenance.

B. Connect wiring according to Division 26 Specification Section "Low-Voltage Electrical Power Conductors and Cables."

3.11 LEAK TEST PIPING SYSTEMS:

A. See Division 22 Specification Section “Leak Test Plumbing Piping Systems” for testing requirements.

END OF SECTION 221316

# SECTION 224200 – PLUMBING FIXTURES AND ACCESSORIES

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 22.

### 1.2 SUMMARY

A. This section includes the requirements for plumbing fixtures and accessories using the following:

1. Water closets.
2. Lavatories.
3. Non laboratory countertop sinks.
4. Wall hung sinks.
5. Fixture hardware and trim.
6. Miscellaneous accessories.

### 1.3 DEFINITIONS

A. Accessible: Describes a plumbing fixture, building, facility, or portion thereof that can be approached, entered, and used by physically handicapped people.

B. Accessory: Device that adds effectiveness, convenience, or improved appearance to a fixture but is not essential to its operation.

C. Appliance: Device or machine designed and intended to perform a specific function.

D. Appurtenance: Device or assembly designed to perform some useful function when attached to or used with a fixture.

E. Equipment: Devices used with plumbing fixtures or plumbing systems to perform a certain function for plumbing fixtures but that is not part of the fixture.

F. Fitting: Fitting installed on or attached to a fixture to control the flow of water into or out of the fixture.

G. Fixture: Installed receptor connected to the water distribution systems, which receives and makes available potable water and discharges the used liquid or liquid borne wastes directly or indirectly into the drainage system. The term "Fixture" means the actual receptor, except when used in a general application where terms "Fixture" and "Plumbing

Fixture" include associated trim, fittings, accessories, appliances, appurtenances, support, and equipment.

H. Roughing-In: Installation of piping and support for the fixture prior to the actual installation of the fixture.

I. Device normally concealed in building construction, for supporting and securing plumbing fixtures to walls and structural members. Supports for urinals, lavatories, and sinks are made in types suitable for fixture construction and the mounting required. Categories of supports are:

1. Carrier: Floor mounted support for wall mounted water closet, and support fixed to wall construction for wall hung fixture.
2. Chair Carrier: Support for wall hung fixture, having steel pipe uprights that transfer weight to the floor.
3. Chair Carrier, Heavy Duty: Support for wall hung fixture, having rectangular steel uprights that transfer weight to the floor.
4. Reinforcement: Wood blocking or steel plate built into wall construction, for securing fixture to wall.

J. Trim: Hardware and miscellaneous parts, specific to a fixture and normally supplied with it required to complete fixture assembly and installation.

1.4 ACTION SUBMITTALS

A. Product Data: For each specified product, include manufacturers cut sheets, dimensional data, performance data, installation instructions, color, power requirements, specified options, and warranty information.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Include a copy of each approved submittal along with any applicable maintenance data in the project operation and maintenance manual.

B. Maintenance Materials: Furnish extra materials that are packaged with protective covering for storage and identified with labels describing contents.
1. Faucet Washers and O-rings: Furnish quantity of identical units not less than 10% of amount of each installed.
2. Faucet Cartridges and O-rings: Furnish quantity of identical units not less than 5% of amount of each installed.
3. Flushometer Repair Kits: Furnish quantity of identical units not less than 10 % of amount of each flushometer installed.
4. Toilet Seats: Furnish quantity of identical units not less than 5% of amount of each type toilet seat installed.

1.6 WARRANTY AND GUARANTEE

A. See Division 22, Specification Section “Basic Mechanical Requirements – Plumbing” for warranty and guarantee requirements.

**PART 2 - PRODUCTS**

2.1 GENERAL PRODUCT REQUIREMENTS

A. Equipment Design and Selection: Plumbing fixtures and accessories shall be designed and selected, for the intended use, in accordance with the scheduled capacities on the drawings and the requirements of this specification.

B. General: Provide all plumbing fixtures, and safety fixtures indicated on the drawings and as specified below, complete with all trim, hangers, fittings etc. for a complete installation. All exposed metal parts shall be polished chrome plated brass unless otherwise specified below.

C. Provide an outlet floor drain trap primer for each floor drain where indicated on the drawings and as specified below.

2.2 STANDARD PLUMBING FIXTURE SCHEDULE

A. P-1A - Water Closets: Wall hung, back outlet.

1. Basis of Design Product: Subject to compliance with requirements, provide American Standard Afwall wall hung water closet 2257.101, elongated bowl, one and one-half (1-1/2) inch top spud or comparable product by one (1) of the following:

    a. Crane Plumbing, L.L.C.
    b. Eljer.
    c. Kohler Co.

2. Bowl:
    a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
    b. Material: White Vitreous china.
    c. Type: Siphon jet.
    d. Style: Flushometer valve.
    e. Rim Contour: Elongated.
    f. Water Consumption: 1.6 gallons per flush.
    g. Spud Size and Location: one and one-half (1-1/2) inch; top.

3. Coordinate "Flushometer Valve" Subparagraph below with "Flushometer Valves" Article.

4. Flushometer Valve: FV-1

5. Toilet Seat:
   a. Basis-of-Design Product: American standard # 5901.100.
   b. Standard: IAPMO/ANSI Z124.5.
   c. Material: Plastic.
   d. Type: Commercial Heavy duty
   e. Shape: Elongated rim, open front.
   f. Hinge Material: No corroding metal.
   g. Color: White

6. Support:
   a. Basis of Design Product: Zurn Model Z1203-N adjustable horizontal siphon jet no-hub for single and Zurn Model Z1203-ND4 for back to back or comparable product by one of the following:

      1) Josam
      2) Smith

   b. Standard: ASME A112.6.1M.

   c. Description: Waste-fitting assembly as required to match drainage piping material and arrangement with faceplates, couplings gaskets, and feet; bolts and hardware matching fixture.

7. Mounting height:

   a. P-1A: Accessible: Sixteen One Half (16 1/2”) inches from finished floor to rim.

B. P-3A - Lavatory: Vitreous china, wall mounted, with back.

1. Basis of Design Product: Subject to compliance with requirements, provide American Standard Lucerne 0356.015 or comparable product by one (1) of the following:

   a. Crane.
   b. Elger.
   c. Kohler Co.

2. Fixture:

   a. Standard: ASME A112.19.2/CSA B45.1.
   b. Type: For wall hanging.
   c. Nominal Size: Twenty five (25) inches x eighteen (18) inches.
   d. Faucet-Hole Punching: Three holes, four (4) inch centers.
   e. Faucet-Hole Location: Top.

f. Color: White.
g. Mounting Material: Chair carrier.

3. Support:

a. Basis of Design Product: Zurn Model Z1231.
b. ASME A112.6.1M, Type II, concealed-arm lavatory carrier with escutcheons.

4. Mounting Height: Thirty four (34) inches above finished floor. (accessible)

5. Faucet: LAF-1

6. Supply Fittings: See Section: Plumbing Fixtures Hardware and Trim, Supply Fittings.

7. Waste Fittings: WF-1

C. P-10 – Non Laboratory Countertop Sink: Stainless steel, countertop mounted.
1. Basis of Design Product: Subject to compliance with requirements, provide Just Manufacturing Model LLQ-17519-B-GR.

2. Fixture:

a. Standard: ASME A112.19.3/CSA B45.4.
b. Type: Ledge back.
c. Number of Compartments: One
d. Overall Dimensions: Seventeen and one half (17-1/2) inch by nineteen (19) inch.
e. Metal Thickness: 0.050 inch.
f. Compartment:

1) Dimensions: Eleven and one half (11-1/2) inches wide by sixteen (16) inches long and seven and six (6) inches deep.
2) Drain Location: Centered in compartment.

3. Mounting: On counter with sealant.
4. Faucet Hole: One (1) hole, centered.
5. Laboratory Faucet: LSF-2
6. Supply Fittings: See Section: Plumbing Fixtures Hardware and Trim, Supply Fittings.
7. Waste Fittings: WF-1

2.3 PLUMBING FIXTURE HARDWARE AND TRIM

A. Flush Valves - Water Closets:

1. Lever-Handle, Diaphragm Flushometer Valve FV-1

a. Basis of Design Product: Subject to compliance with requirements, provide Sloan Royal 111 flushometer with vacuum breaker, one (1) inch screw driver angle stop and flush connection or comparable product by one (1) of the following:

1) Josam.
2) Zurn Industries, LLC; Commercial Brass and Fixtures.

b. Standard: ASSE 1037.
c. Minimum Pressure Rating: 125 psig.
d. Features: Include integral check stop and backflow-prevention device.
e. Material: Brass body with corrosion-resistant components.
f. Exposed Flushometer-Valve Finish: Chrome plated.
g. Style: Exposed.
h. Consumption: 1.6 gal per flush.
i. Minimum Inlet: One (1) inch.
j. Minimum Outlet: NPS 1-1/4.
k. Trap Primer: Provide the TP variation for one (1) FV in each toilet room with a floor drain where indicated on the drawings.

B. Lavatory Sink Faucets (LAF):

1. Lavatory Faucets LAF-1: Manual-type, two-handle mixing, commercial, solid-brass valve.

a. Basis of Design Product: Subject to compliance with requirements, provide American Standard Model 6502.170 Monterrey Faucet complying with Standard ASME A112.18.1/CSA B125.1, and NSF Standard Comply NSF/ANSI 61, "Drinking Water System Components - Health Effects," for faucet materials that will be in contact with potable water.
b. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punching; coordinate outlet with spout and fixture receptor.
c. Body type in "Body Type" Subparagraph below must match fixture hole punching.
d. Body Type: Widespread**.**
e. Body Material: Commercial, solid brass.
f. Finish: Polished chrome.
g. Maximum Flow Rate: 1.5 gpm.
h. Valve Handle(s): Wrist blade**,** 4 inches.

i. Supply: Three eights (3/8) inch supply stops with lead free angle valves and wall type escutcheon plates. See article below.

C. Countertop Sink Faucets (LSF):

1. Non Laboratory Countertop Sink Faucet LSF-2: Deck mounted hot and cold water mixing faucet with vacuum breaker.

a. Basis-of-Design Product: Subject to compliance with requirements, provide Chicago Faucets Model 786-GN2FC319ABCP.
b. Standard: ASME A112.18.1/CSA B125.1.
c. General: Coordinate faucet inlets with supplies and fixture hole punching; coordinate outlet with spout and fixture receptor.
d. Body type in "Body Type" Subparagraph below must match fixture hole punching.
e. Body Material: Commercial, solid brass.
f. Finish: Polished chrome.
g. Eight (8) inch rigid/swing gooseneck spout with aerator.

D. Supply Fittings:

1. NSF Standard: Comply with NSF/ANSI 61, "Drinking Water System Components - Health Effects," for supply-fitting materials that will be in contact with potable water.
2. Standard: ASME A112.18.1/CSA B125.1.
3. Supply Piping: #10/8 three eight (3/8) inch supply risers twelve (12) inches long. Chrome-plated-brass pipe or chrome-plated copper tube. Include chrome-plated-brass or stainless-steel wall flange.
4. Supply Stops: Three eights (3/8) chrome-plated-brass, one-quarter-turn, lead free angle valves with inlet connection matching supply piping.
5. Operation: Wheel handle.

E. Waste Fittings:

1. Standard: ASME A112.18.2/CSA B125.2.
2. Type WF-1 - Lavatory Sinks:

a. Drain: Grid type with NPS 1-1/4 offset and straight tailpiece.
b. Trap: One and one-half (1-1/2) inch cast brass ‘P’ trap with cleanout.

F. Trap Primer:

1. For each floor drain within the restroom, provide a Sloan Vacuum Breaker VBF-72-A1 trap primer chrome plated flush connection with a special three eights (3/8) inch adaptor connection from the flushometer outlet, for a flex-bend connection,

and a wall flange, for each floor drain. Trap primer shall be as manufactured by Sloan on approved equal.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before plumbing fixture installation.

B. Examine counters and walls for suitable conditions where lavatories will be installed.

C. Examine walls and floors for suitable conditions where plumbing fixtures will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 STANDARD PLUMBING FIXTURE INSTALLATION

A. Water-Closet Installation:

1. Install level and plumb according to roughing-in drawings.
2. Install floor-mounted water closets on bowl-to-drain connecting fitting attachments to piping or building substrate.

B. Lavatory Installation:

1. Install lavatories level and plumb according to roughing-in drawings.
2. Install supports, affixed to building substrate, for wall-mounted lavatories.
3. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings.
4. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories. Comply with requirements in Division 22 Section "Insulation for Plumbing Piping and Equipment".

C. Support Installation:

1. Use carrier supports with waste-fitting assembly and seal.
2. Install floor-mounted, bottom-outlet plumbing fixtures attached to building floor substrate, onto waste-fitting seals; and attach to support.
3. Install wall-mounted, plumbing fixtures supports with waste-fitting assembly and waste-fitting seals; and affix to building substrate.

D. Flushometer-Valve Installation:

1. Install flushometer-valve, water-supply fitting on each supply to each water closet and urinal.
2. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
3. Install lever-handle flushometer valves for accessible water closets and urinals with handle mounted on open side of water closet.
4. Install actuators in locations that are easy for people with disabilities to reach.

E. Install toilet seats on water closets.

F. Wall Flange and Escutcheon Installation:

1. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations and within cabinets and millwork.
2. Install deep-pattern escutcheons if required to conceal protruding fittings.

G. Joint Sealing:

1. Seal joints between plumbing fixture and walls and floors using sanitary-type, one (1) part, mildew-resistant silicone sealant.
2. Match sealant color to water-closet color.

3.3 CONNECTIONS

A. Connect water closets with water supplies and soil, waste, and vent piping. Use size fittings required to match water closets.

B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

C. Comply with water piping requirements specified in Division 22 Specification Section "Domestic and Laboratory Water Piping Systems and Specialties."

D. Comply with soil and waste piping requirements specified in Division 22 Specification Section "Sanitary, Chemical and Vent Piping Systems."

E. Where installing piping adjacent to plumbing fixture, allow space for service and maintenance.

3.4 ADJUSTING

A. Operate and adjust plumbing fixtures and controls. Replace damaged and malfunctioning water closets, fittings, and controls.

B. Adjust water pressure at flushometer valves to produce proper flow.

C. Adjust fixture flow regulators for proper flow and stream height.

## 3.5 CLEANING AND PROTECTION

A. Clean plumbing fixtures and fittings with manufacturers' recommended cleaning methods and materials.

B. Install protective covering for installed plumbing fixtures and fittings.

C. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 224200

# SECTION 230000 – BASIC MECHANICAL REQUIREMENTS – HVAC

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01Specification Sections, apply to this section and all other sections of Division 23.

### 1.2 SUMMARY

A. This Section includes general administrative and procedural requirements, as well as the following basic mechanical materials and methods:

1. Codes, organizations, standards, and abbreviations
2. Submittals
3. Site visit
4. Outages
5. Variances
6. Cutting, welding and burning
7. Performance requirements
8. Material and equipment
9. Related work
10. Contract drawings.
11. Coordination
12. Demolition
13. Fire safe materials
14. UL requirements
15. Coordination drawings
16. Construction record documents.
17. Operation and maintenance manuals
18. Fire stops and smoke seals
19. Guarantee / Warranty
20. Pipe and equipment roof curbs and supports
21. Equipment roughins
22. Cutting and patching
23. Installation requirements common to equipment specification sections
24. Excavation and back fill
25. Temporary service
26. Demonstrations
27. Final cleaning

### 1.3 CODES, ORGANIZATIONS, STANDARDS AND ABBRIVIATIONS

A. Codes: All material and equipment provided and installed as part of these construction documents shall be in compliance with the latest edition of the following codes as adapted by the State of Maryland for the following:

1. IBC: International Building Code
2. IMC: International Mechanical Code
3. IECC: International Energy Conservation Code
4. NEC: National Electrical Code
5. NFPA 90A: Standard for the Installation of Air Conditioning and Ventilation Systems
6. NFPA 90B: Standard for the Installation of Warm Air Heating and Air Conditioning Systems
7. NFPA 101: Life Safety Code
8. PHCC: National Standard Plumbing Code Illustrated

B. Organizations and Standards: The following list of organizations and standards are referenced in the HVAC Specification Sections and are included here for reference:

1. AABC: Associated Air Balance Council
2. ADC: Air Diffusion Council
3. AEC: Architecture, Engineering and Construction
4. AGA: American Gas Association
5. AHRI: Air Conditioning, Heating and Refrigeration Institute
6. AMCA: Air Moving and Conditioning Association
7. ANSI: American National Standards Institute
8. API: American Petroleum Institute
9. ARI: Air Conditioning and Refrigeration Institute
10. ASCE: American Society of Civil Engineers
11. ASCE-SEI: American Society of Civil Engineers - Structural Engineering Institute
12. ASHRAE- American Society of Heating, Refrigerating and Air Conditioning Engineers
13. ASME: American Society of Mechanical Engineers
14. ASTM: American Society for Testing and Materials
15. AWS: American Welding Society
16. AWWA: American Water Works Association
17. BAS: Building Automation System
18. CFR: Code of Federal Regulations
19. CGA: Compressed Gas Association
20. CS: Commercial Standard
21. CSA: Canadian Standards Association
22. CTI STD: Cooling Technology Institute - Standard
23. CTI ATC: Cooling Technology Institute – Acceptable Test Code
24. EJMA: Expansion Joint Manufacturers Association
25. EPA: Environmental Protection Agency
26. FM: Facilities Management
27. FMG: Factory Mutual Global

28. FSA: Fuel Sealing Association
29. FSA – NMEJ: Fuel Sealing Association - Non-Metallic Expansion Joint
30. IAPMO: International Association of Plumbing and Mechanical Officials
31. IBR: Institute of Boiler and Radiator Manufacturers
32. ICC: International Code Council
33. ICC–ES: International Conference on Computational & Experimental Engineering and Sciences
34. IEC: International Electrotechnical Commission
35. IEEE: Institute of Electrical and Electronics Engineers
36. IESNA: Illuminating Engineering Society of North America
37. ISO: International Organization for Standardization
38. ITT: International Telephone & Telegraph Corporation
39. MOSHA- Maryland Occupational Safety and Health Administration
40. MSHA: Mine Safety and Health Administration
41. MSS: Manufacturers Standardization Society
42. MSSP: Manufacturers Standards Society of the Valve and Fittings Industry
43. MSS SP: Manufacturers Standardization Society Standard Practice
44. NADCA: National Air Duct Cleaners Association
45. NAIMA: North American Insulation Manufacturers Association.
46. NAIMA – AH: North American Insulation Manufacturers Association – Air Handling
47. NEBB: National Environmental Balancing Bureau
48. NEC: National Electric Code
49. NEMA: National Electrical Manufacturers Association
50. NEMA – ICS: National Electrical Manufacturers Association – Industrial Control and Systems
51. NEMA – KS: National Electrical Manufacturers Association – Kansas
52. NEMA – MG: National Electrical Manufacturers Association – Motors & Generators
53. NFPA: National Fire Protection Association
54. NICET: National Institute for Certification in Engineering Technologies
55. NIOSH: National Institute for Occupational Safety and Health
56. OSHA - Occupational Safety and Health Administration
57. SE: System Engineering
58. SEI: Software Engineering Institute
59. SMACNA- Sheet Metal and Air Conditioning Contractors National Association
60. TEMA: Tubular Exchanger Manufacturers Association
61. ULC: Underwriters' Laboratories – Canada
62. UM: University of Maryland
63. UMB: University of Maryland, Baltimore
64. UMB-A/E: University of Maryland, Baltimore – Architect/Engineer
65. UMB-FM: University of Maryland, Baltimore – Facilities Management
66. UMB-PM: University of Maryland, Baltimore – Project Manager

C. Abbreviations: The following list of abbreviations are referenced in the HVAC Specification Sections and are included here for reference:

1. A/C: Air Conditioning
2. ADA: American Disability Act
3. ASJ: All Service Jacket
4. ATC: Automatic temperature Control
5. BACnet: Building Automation and Control Networks
6. BACnet IP: Internet Protocol
7. BACnet MSTP: Master Slave Token Passing
8. BACnet TCP: Transmission Control Protocol
9. BAS: Building Automation System
10. BMS: Building Management System
11. BTU: British Thermal Unit
12. CAD: Computer Aided Design
13. CD-ROM: Compact Disk – Read Only Material
14. CFC: Chlorofluorocarbon
15. CFM: Cubic Feet per Minute
16. CM: Construction Manager
17. Corp: Corporation
18. CV: Coefficient of Variation, Constant Volume
19. CWP: Cold Working Pressure
20. ºC: Degree Celsius
21. ºF: Degree Fahrenheit
22. DDC: Direct Digital Control
23. DIA: Diameter
24. DOC: Document
25. DP: Differential Pressure
26. Dwg: Drawing
27. EEPROM: Electrically Erasable, Programmable Read-Only Memory
28. EMT: Electrical Metallic Tubing
29. EDPM: Ethylene Propylene Diene Terpolymer Rubber
30. FIT: Fast Installation Technique
31. FLN: Floor Local Network
32. FNPT: Female National Pipe Thread
33. FPM: Feet Per Minute
34. FRP: Fiberglass Reinforced Pipe
35. FSK: Foil Scrim Kraft
36. FTU: Fin Tube
37. Ft.$^2$: Square Feet
38. GAL: Gallon(s)
39. GETU: General Exhaust Terminal Unit
40. GFI: Ground Fault Interrupter
41. GPM: Gallons Per Minute
42. HCFC: Hydrochlorofluorocarbons
43. HEPA: High Efficiency Particulate Absorption
44. Hr: Hour
45. $H_g$: Mercury

46. HP: Horse Power
47. HVAC: Heating Ventilation and Air Conditioning
48. $H_z$: Hertz
49. IBC: International Building Code
50. IEQ: Indoor Environmental Quality
51. Inc: Incorporated
52. ID: Inside Diameter
53. IN: Inches
54. Khz: Kilohertz
55. KVA: Kilo Volt Ampere
56. KVAR: Kilo Volt Amperes, Reactive
57. KVARH: Kilo Volt Amps Reactive Hours
58. kW: Kilowatt
59. LAN: Local Area Network
60. Lb: Pound
61. Lbf/inch: Pound Force per Inch
62. Lbs: Pounds
63. LCD: Liquid Crystal Display
64. LED: Light Emitting Diode
65. mA: Milli Ampere
66. mL: Milli Liter
67. MAX: Maximum
68. MERV: Minimum Efficiency Rating Value
69. MIN: Minimum
70. MPa: Megapascal
71. N/A: Not Applicable
72. NBR: Nitrile Butadiene Rubber
73. NEC: National Electric Code
74. NG: Natural Gas
75. NMEJ: Non-Metallic Expansion Joint
76. No.: Number
77. NOM: Nominal
78. NPS: Nominal Pipe Size
79. NPT: National Pipe Thread
80. NRC: Noise Reduction Coefficient
81. OC: On Center
82. OD: Outside Diameter
83. ODP: Open Drip Proof
84. OZ: Ounce
85. PD: Pressure Drop
86. Pdf: Portable Document Format
87. pH: Potassium Hydrogen
88. PPM: Parts per Million
89. PPS: Plastic Pipe Systems
90. PSI: Pounds per Square Inch
91. PSIG: Pounds per Square Inch Gage

92. P/T: Pressure/Temperature
93. PTFE: Polytetraflouroethylene
94. PVC: Polyvinyl Chloride
95. RPM: Revolutions per Minute
96. RPTFE: Reinforced PolyTetraFluoroEthylene
97. S/S: Stainless Steel
98. STC: Sound Transmission Class
99. STU: Supply Terminal Unit
100. Sq.yd.: Square Yard
101. TAB: Testing, Adjusting, and Balancing
102. TEAO: Totally Enclosed Air Over Enclosure
103. TEC: Terminal Equipment Controller
104. TENV: Totally Enclosed Non Ventilating Enclosure
105. TFE: Tetrafluoroethylene, Trifluoroethanol?
106. TORR: Unit of Pressure Equal to 1/760 Atmosphere
107. TRU: Terminal Reheat Unit
108. TSS: Total Suspended Solids
109. UH: Unit Heater
110. US: United States
111. USA: United States of America
112. USB: Universal Serial Bus
113. UPS: Uninterrupted Power Supply
114. UV: Ultraviolet
115. V: Volt
116. VAV: Variable Air Volume
117. VOC: Volatile Organic Compounds
118. VSD: Variable Speed Drive
119. WG: Water Gage

## 1.4 SUBMITTALS

A. General: For general requirements see Architectural Specification Division 01 Section "Submittals".

B. HVAC Submittals: Provide submittals for all material, equipment and/or supports as specified in Division 23 and where indicated on the drawings and details. For material and product data submission requirements see Division 23 Specification Sections. At a minimum the following submittals shall be provided as required by the project:

1. Pipe, fittings and accessories for each system.
2. Valves, strainers and unions for each system.
3. Insulation (pipe, duct and equipment).
4. Hangers and supports.
5. AHU’s.
6. Split system AC units.
7. Ventilation fans.

8. Terminal heating units (UH).
9. Air terminal units (STU, GETU, FHETU).
10. Air Devices.
11. Duct systems.
12. Building automation system.
13. Identification (labels, tags valve schedule).
14. Equipment supports.

C. Submittal File Format: File formats for each submittal shall be electronically as follows:

1. Product Data File: “pdf” file format.
2. Drawings: “pdf” and “dwg” formats.
3. Coordinated Drawings: “pdf” or “dwg” file formats.
4. Schedules: “xl” file format.

1.5 SITE VISIT

A. Prior to preparing the bid, the HVAC mechanical subcontractor shall visit the site and become familiar with all existing conditions. Make all necessary investigations as to locations of utilities and all other matters which can affect the work. No additional compensation will be made to the contractor as a result of his failure to familiarize himself with the existing conditions under which the work must be performed.

1.6 OUTAGES

A. For all work requiring an outage, the HVAC mechanical subcontractor shall submit an outage request to the UMB Project Manager, using the UMB Standard Request for Outage Form which is available through the UMB Design and Construction Web Site at http://www.umaryland.edu/designandconstruction/, under the Documents Link. The existing HVAC system shall remain operational unless turned off by University personnel during the construction of the project.

B. Unless otherwise specified, outages of any services required for the performance of this contract and affecting areas other than the immediate work area shall be scheduled at least ten days (10) days in advance with the Office of Facilities Management. All such outages shall be performed on other than normal duty hours.

C. All HVAC outages which will interfere with the normal use of the building in any manner shall be done at such times as shall be mutually agreed upon by the contractor and the Office of Facilities Management.

D. The HVAC contractor shall include in his price the cost of all premium time required for outages and other work which interferes with the normal use of the building, which will be performed, in most cases, during other than normal work time and at the convenience of the University.

E. The operation of HVAC valves or switches; required to achieve an outage must be accomplished by University personnel only. Prospective subcontractors under this section are cautioned that the unauthorized operation of HVAC valves, power switches, or other control devices by their personnel can result in extremely serious consequences for which the contractor will be held accountable.

1.7 VARIANCES

A. Where variances occur between the drawings and specifications or within either document itself, the item or arrangement of better quality, greater quantity or higher cost shall be included in the contract price. The Engineer shall decide on the item and manner in which the work shall be provided.

1.8 CUTTING, WELDING, BURNING

A. Before the contractor and/or any sub-contractor commences any cutting, welding, burning, brazing (pipe sweating), the contractor shall obtain a hot work permit from Environmental Health and Safety at extension 1-410-706-3490.

B. The hot work permit copy shall remain on the job site at the hot work location until such work is completed at which time the permit shall be returned to Environmental Health and Safety.

1.9 PERFORMANCE REQUIREMENTS

A. Contract drawings are generally diagrammatic and do not indicate all offsets, fittings, transitions, access panels and other specialties required.

B. Arrange HVAC piping, ductwork, equipment and other work generally as shown on the contract drawings, providing proper clearances and access.

C. Where departures are proposed because of field conditions or other causes, prepare and submit detailed shop drawing submittal for approval in accordance with Submittals specified below.

D. The Architect may make reasonable changes in location of equipment piping and ductwork up to the time of rough-in or fabrication.

1.10 MATERIALS AND EQUIPMENT

A. The contract drawings and system performances have been designed on the basis of using the particular manufacturer’s products specified or scheduled on the contract drawings.

B. Products of other manufacturer’s listed in the specification shall be permitted provided as follows:

1. Products meet all of the requirements of the specifications.
2. Make, without additional cost to the Owner, all adjustments for deviations, such that the final installation is complete and functions as the basis of design product is intended.

C. Products with dimensions or other characteristics different from the basis of design product that render their use impractical or cause functional fit, access, or connection problems, shall not be acceptable.

1.11 COORDINATION, SEQUENCING AND SCHEDULING

A. Coordinate HVAC systems, equipment, and materials installation with other building components.

B. Utilities: Coordinate connection of HVAC systems with exterior underground services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.

C. Chases: Arrange for chases, slots, and openings in building structure during progress of construction to allow for mechanical installations.

D. Sleeves: Coordinate the installation of required supporting devices and set sleeves in poured in place concrete and other structural components as they are constructed.

E. Sequencing: Sequence, coordinate, and integrate installations of HVAC materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.

F. Electrical Services: Coordinate connection of electrical services.

G. Access: Coordinate requirements for access panels and doors where HVAC items requiring access are concealed behind finished surfaces. Access panels and doors are specified in Architectural Specification Section "Access Doors."

H. Scheduling: Schedule and coordinate the delivery of material and equipment with other trades to avoid delivery conflicts.

1.12 FIRE SAFE MATERIALS

A. Unless otherwise indicated, materials shall conform to UL, NFPA or ASTM standards for fire safety with smoke and fire hazard rating not exceeding flame spread of twenty five (25) and smoke developed of fifty (50).

1.13 UNDERWRITER'S LABORATORY (UL) REQUIREMENTS

A. All equipment containing electrical components and provided as part of the mechanical specifications shall bear the Underwriter's Laboratory (UL) label, as a complete packaged system.

1. Equipment not provided with a UL label shall be tested in the field, certified and provided with a UL label at the installer's expense.
2. Field testing shall be performed by a testing agency approved by the authority having jurisdiction.

1.14 CONSTRUCTION RECORD DOCUMENTS

A. The mechanical contractor shall maintain a set of construction record documents during the construction period in accordance with Specification Division 01 Section "Project Closeout".

1.15 OPERATION AND MAINTENANCE MANUALS

A. Prepare maintenance manuals in accordance with Specification Division 01 Section "Project Closeout."

1.16 FIRE STOPS & SMOKE SEALS

A. Fire stops and smoke seals shall be provided by one (1) manufacturer for all trades. See Architectural Specification Division 7 for requirements.

B. Provide fire stops and smoke seals for all mechanical services installed and existing services in the project area that pass through fire rated partitions, wall, floors etc. Services shall include all ductwork, conduit, metal and plastic piping, cables, etc. The area around penetrations including any voids between them must be filled in and sealed with UL fire rated materials equal to the adjoining materials. All fire stop insulation devices and sealants shall maintain the fire resistance integrity of the floor, wall partition, etc. and meet ASTM 814-83 F&T rating for time, hours and temperature rise. All fire stopping and sealants shall allow for expansion and contraction movement without pumping free of openings. Provide U. L. System Numbers in product submittals for each Fire Stop & Smoke Seal Application.

C. The installer of firestop and smoke seal materials shall be a firm licensed or otherwise approved by the manufacturer of the materials and have at least five (5) years experience installing firestop and smoke seal materials. Installer shall comply with the material manufacturer's recommendations and installation requirements and ASTM and applicable code requirements.

D. All fire stop and smoke seal materials shall be as manufactured by any one of the following manufacturers:

1. Specified Technologies Inc. (STI)

2. DOW Corning Corp.
3. 3M Inc.
4. Hilti

1.17 WARRANTY/GUARANTEE

A. All materials, equipment, etc. provided by the general contractor and/or his subcontractors shall be warranted and guaranteed to be free from defects in workmanship and materials for a period of two (2) years from the date of substantial completion and acceptance of work by UMB. Any defects in workmanship, materials, or performance which appear within the guarantee period shall be corrected by the contractor without cost to the owner, within a reasonable time, to be specified by UMB. In default thereof, owner may have such work done and charge the cost of same to the contractor. In addition to the above statement the Warranty/Guarantee Period shall also include all labor cost related to all warranty work. For compressorized equipment include an additional three (3) year Warranty/Guarantee Period.

**PART 2 – PRODUCTS**

2.1 LISTED MANUFACTURERS:

A. Listed Manufacturers: The listed manufacturers indicated in Part 2 of each specification section as the basis of design represents the minimum level of quality for materials and equipment that is acceptable to UMB. Unless otherwise indicated in each specification section, contractors may submit material and equipment by non listed manufacturers provided said submittals meet all of the requirements of these specifications. All submitted materials and equipment are subject to approval by the A/E and UMB.

B. Approved Equal Equipment Layouts: The equipment layouts and the related mechanical and electrical service connections, access space and supports indicated on the construction documents represent equipment provided by the specified basis of design manufacturer and model number. When the successful bidder chooses to provide “or approved equal” equipment by one (1) of the other listed manufacturers in the specifications, the bidder shall be responsible for providing all adjustments and modifications to the services necessary to make connections to the equipment, the bidder shall be responsible for installing the equipment such that all required clear access space is maintained, and the bidder shall be responsible for providing all adjustments and modifications to the equipment mounting and supports. All adjustments and modifications shall be provided by the bidder and appropriate subcontractors at no additional cost to the project.

2.2 CONCRETE AND MASONRY WORK

A. Concrete: 3,500 psi compressive strength after twenty eight (28) days.

B. Grout shall be non-shrink, high strength type, free of iron or chlorides and suitable for use in contact with all metals, without caps or other protective finishes.

2.3 GROUT

A. Nonshrink, Nonmetallic Grout: ASTM C 1107, Grade B.

1. Characteristics: Post hardening, volume adjusting, dry, hydraulic cement grout, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5,000-psi (34.50MPa), twenty eight (28) day compressive strength.
3. Packaging: Premixed and factory-packaged.

2.4 COMBINATION MOTOR STARTERS, VFD'S, AND CONTROLLERS – HVAC EQUIPMENT

A. Combination motor starters, VFD's and/or controllers shall be provided for all motors serving HVAC equipment as follows:

1. Skid Mounted Equipment: Combination motor starters, VFD's and/or controllers shall be provided by the equipment manufacturer as part of Division 23.
2. Non Skid Mounted Equipment: Combination motor starters, VFD's and/or controllers shall be provided as part of Division 26.

**PART 3 - EXECUTION**

3.1 EQUIPMENT ROUGH IN

A. Verify final locations for rough ins with field measurements and with the requirements of the actual equipment to be connected.

B. Refer to equipment specifications included in the architectural, mechanical, and electrical specifications for equipment rough in requirements.

3.2 MECHANICAL INSTALLATIONS - HVAC

A. Verify all dimensions by field measurements.

B. Where HVAC systems, materials and equipment are intended for overhead installation, and where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible. Notify UMB - PM prior to installation of HVAC components when headroom is less than 7'-6" and/or where existing system components will be below the new finished ceiling height. Notification shall be through the "RFI" process.

C. Install HVAC systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown

only in diagrammatic form. Where coordination requirements conflict with individual system requirements, identify the conflict and submit and "RFI" for each conflict to the Architect.

D. Install HVAC systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components.

E. Install HVAC equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location.

F. Install access panel or doors where units are concealed behind finished surfaces. Access panels and doors are specified in the Architectural Specifications.

G. Install HVAC systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

H. The contractor shall confirm that all pressure vessels are installed in full compliance with the requirements of the Sate Inspector's Office for Boilers and Pressure Vessels. Refer to "Closeout Procedures" in this Section for additional requirements.

3.3 CUTTING AND PATCHING

A. General: Perform cutting and patching in accordance with Specification Division 01 Section "Cutting and Patching" In addition to the requirements specified in Specification Division 01, the following requirements apply:

1. Patch Materials: Patch finished surfaces and building components using new materials specified for the original installation and using experienced Installers. Installers' qualifications refer to the materials and methods required for the surface and building components being patched.

3.4 PAINTING AND FINISHING

A. Refer to Architectural Specification Section "Painting" for field painting requirements.

B. Damage and Touch Up: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

C. Do not paint manufacturer's labels or tags.

3.5 CONCRETE BASES

A. Construct concrete equipment bases of dimensions indicated, but not less than four (4) inches (100 mm) larger than supported unit in both directions. Follow supported

equipment manufacturer's setting templates for anchor bolt and tie locations. Use 3,000-psi (20.70MPa), twenty eight (28) day compressive strength concrete and reinforcement bars as specified in the architectural specifications.

3.6 ERECTION OF METAL SUPPORTS AND ANCHORAGE

A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.

B. Field Welding: Comply with AWS D1.1 "Structural Welding Code Steel."

3.7 PENETRATION OF WATERPROOF CONSTRUCTION

A. Coordinate the work to minimize penetration of waterproof construction, including roofs, exterior walls and interior waterproof construction.

B. Furnish and install drains, curbs, vent assemblies, sleeves, flashing, etc. specifically designed for application to the particular construction. Install system in accordance with the roofing manufacturer's instructions.

3.8 EXCAVATION AND BACKFILLING

A. General: Perform all necessary excavation and backfilling necessary for the installation of underground HVAC services as part of Division 23 in accordance with the architectural specifications.

3.9 CLEANING AND FINISHES

A. Clean surfaces prior to application of insulation, adhesives, coating, and paint.

B. Provide factory applied finish where specified.

C. Protect all finishes, and restore all finishes to their original condition if damaged as a result of work installed as part of the mechanical specifications.

D. Remove all construction marking and writing from exposed equipment, ductwork, piping and building surfaces.

3.10 LINTELS

A. Lintels shall be provided for openings in masonry, brick, concrete, etc. walls to accommodate work of this division.

1. Lintels shall be provided under this division when not being provided under other divisions. Lintels shall be approved by the Architect.

3.11 ELECTRICAL REQUIREMENTS

A. Unless otherwise indicated, furnish and install control and interlock wiring for the equipment furnished under this division. In general, power wiring and motor starting equipment will be provided as specified in the electrical specifications.

1. Where the electrical requirements of the equipment furnished differ from the provisions made in the electrical specifications, make the necessary allowances as part of the mechanical specifications.
2. Where no electrical provisions are included in the electrical specifications, include all necessary electrical work as part of the mechanical specifications.

B. All electrical work performed as part of the mechanical specifications shall be provided in accordance with the electrical specifications.

3.12 PROVISIONS FOR ACCESS

A. Furnish and install adequate access to all HVAC and plumbing components. The following list shall be used as a guide only:

1. Equipment
2. Valves
3. Dampers and operators
4. Filters
5. Heating and air conditioning units
6. Controls
7. ATC panels
8. Heating and cooling coils
9. Low point drains

B. Access shall be adequate as determined by the Architect.

C. Refer to contract drawings where access panels have been specifically located.

D. Provide additional access panels for adequate access as indicated in paragraph ‘A’ above.

E. Where access is by means of lift out ceiling tiles or panels mark each access panel using small color coded or numbered tabs. Provide an index chart for identification. Place markers in corner of tile.

3.13 PENETRATION OF WATERPROOF CONSTRUCTION

A. Coordinate the work to minimize penetration of waterproof construction, including roofs, exterior walls and interior waterproof construction.

B. Furnish and install drains, curbs, vent assemblies, sleeves, flashing, etc. specifically designed for application to the particular construction. Install system in accordance with the roofing manufacturer's instructions.

3.14 OPERATION OF EQUIPMENT

A. Clean all systems and equipment prior to initial operation for testing and balancing.

B. Do not operate equipment unless all proper safety devices or controls are operational.

C. Provide all maintenance and service for equipment which is operated during construction.

D. Where specified and otherwise required, provide the services of a manufacturer's factory trained service organization to start the equipment.

3.15 TEMPORARY SERVICE AND EQUIPMENT USE

A. Temporary Service: Unless temporary services are required as part of the project, do not use HVAC systems for temporary services during construction unless authorized in writing by the Architect and/or UMB.

B. Equipment Use: Where such authorization is granted, temporary use of new and or existing equipment shall not limit or otherwise affect warranties or guarantees covering new equipment. Where equipment is used by the contractor the contractor shall perform all required preventive maintenance on the equipment during the construction period. Upon completion of work, clean and restore all new and/or existing equipment to new condition and replace all filters as necessary.

3.16 DEMONSTRATION AND INSTRUCTIONS

A. Demonstrate operation and maintenance of equipment and systems to Owner’s personnel a minimum two (2) weeks prior to date of final inspection.

1. For equipment requiring seasonal operation, perform instructions for other seasons at the same time.
2. Training period shall be performed within one (1), two (2) week period.

B. Use operation and maintenance manuals and video as basis of instruction. Review contents of manual and video with personnel in detail to explain all aspects of operation and maintenance.

C. Demonstrate the following:

1. Start up.
2. Operation.
3. Control.

4. Adjustment.
5. Trouble shooting.
6. Servicing.
7. Maintenance.
8. Shutdown.

D. Provide at least forty (40) hours straight time instruction to the operating personnel.

1. This instruction period shall consist of not less than five (5) eight (8) hour days.
2. Time of instruction shall be designated by the Owner.
3. This instruction shall be in addition to instructional requirements of specific equipment specified elsewhere in the mechanical specifications.

3.17 LUBRICATION

A. All bearings, motors and all equipment requiring lubrication shall be provided with accessible fittings.

B. Before turning over the equipment to the Owner, the Installer shall provide the following:

1. Fully lubricate each item of equipment.
2. Provide one (1) year's supply of lubricant for each type of lubricant.
3. Provide complete written lubricating instructions, together with diagram locating the points requiring lubrication.

C. Motors and equipment shall be provided with grease lubricated roller or ball bearings with Alemite or equal extended grease fittings and drain plugs.

3.18 WALL AND FLOOR PENETRATION

A. All penetrations of partitions, walls and floors by ducts, piping or conduit under Specification Division 23 shall be sealed and caulked. Provide U.L. listed fire stopping systems at penetrations through fire walls as specified in the architectural specifications.

3.19 EQUIPMENT PROVIDED UNDER ANOTHER DIVISION AND BY OTHERS

A. The Installer of products under Specification Division 23 shall make all system connections required to equipment furnished and installed under another division and by others.

B. It shall be the responsibility of the Installer to obtain all necessary data from the equipment supplied under other Divisions.

3.20 CONSTRUCTION RECORD DRAWINGS

A. As the work progresses, the contractor shall record on one (1) set of prints, the installed locations, sizes, and depths of pipes, services, equipment, etc. which may differ from the approved contract drawings.

B. Upon completion of the HVAC installations, the installer shall deliver to the Architect construction manager one (1) complete set of marked-up blueprints of the HVAC contract drawings. The construction manager shall compile the mark up prints into a composite set and transmit the set the architect who shall incorporate the mark ups into the record drawing electronic file.

1. The mark-ups shall be legibly marked in red pencil to show all changes and departures of the installation as compared with the original design.

C. At a minimum include the following installed conditions:

1. Location of all shut off valves, drain valves, and balancing valves with assigned valve tag numbers.
2. Show the location of concealed material and/or equipment requiring service such as strainers, traps, localized A/C units, control valves and/or expansion compensators.
3. Actual entering/leaving invert elevations for steam, and chilled water services for the building.

3.21 CLOSEOUT PROCEDURES

A. Operating and Maintenance Instructions: Submit Complete Package At Least Two (2) Months Prior To Substantial Completion. Arrange for each installer of equipment that requires regular maintenance to meet with the Owner's personnel to provide instruction in proper operation and maintenance. If installers are not experienced in procedures, provide instruction by manufacturer's representatives. Include a detailed review of the following items:
1. Maintenance manuals, including a customized list of preventive maintenance items and annual schedule for maintenance.
2. Record documents.
3. Complete inventory of spare parts and materials.
4. Tools.
5. Lubricants.
6. Fuels.
7. Identification systems.
8. Control sequences.
9. Hazards.
10. Cleaning.
11. Warranties and bonds.
12. Maintenance agreements and similar continuing commitments.

B. As part of instruction for operating equipment, demonstrate the following procedures:

1. Start up.
2. Shut down.
3. Emergency operations.
4. Noise and vibration adjustments.
5. Safety procedures.
6. Economy and efficiency adjustments.
7. Effective energy utilization.

C. Pressure Vessel Inspections by the State of Maryland: For the purpose of obtaining and having UM buildings insured by any commercial insurance carrier, the contractor shall arrange for the inspection of all pressure vessels installed during construction. The contractor shall contact the Office of Boiler and Pressure Vessel Inspections of the Department of Labor, Licensing and Regulations (DLLR), State of Maryland, and arrange for the inspections. The DLLR shall be notified at least thirty (30) days prior to installation. After such inspections are carried out by the State Inspector's office, Certificates of Compliance will be issued to the contractor of record to be turned over to the Owner's representative for compliance with current insurance regulations as part of the Project Documents. Examples of pressure vessels include boilers, heat exchangers, converters, expansion tanks, water heaters, hot water generators and storage tanks. Chillers are excluded and are covered under ASHRAE Guidelines.

3.22 FINAL CLEANING

A. General: General cleaning during construction is required by the General Conditions as indicated in Division 01 Specification Section "Temporary Facilities."

B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to the condition expected in a normal, commercial building cleaning and maintenance program. Comply with manufacturer's instructions.

C. Remove all mechanical clipping, wiring, nuts, bolts, etc. left on top of ceilings and ceiling tiles.

3.23 PROJECT PUNCH OUT

A. Architect/Engineer will perform punch out reviews and will provide the Contractor with a list of punch list items to be completed before contract close out. Each and every punch list item shall be initialed and dated by the Contractor when the work is complete. The Architect/ Engineer will not perform any punch list verification until all items have been completed, initialed, dated and the list returned to the Architect/Engineer. If any items have been initialed as being completed by the Contractor and the Architect/Engineer determines that the work is not complete, the Architect/Engineer shall be reimbursed by the Contractor at his regular hourly rate for any and all items requiring revisiting of the site by the Architect/Engineer. Reimbursement shall be made by deducting the Architect/Engineer fee from the Contractor's final payment.

END OF SECTION 230000

# SECTION 230513 – MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 23.

### 1.2 SUMMARY

A. This section includes the general requirements for single (1) phase and three (3) phase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

### 1.3 QUALITY ASSURANCE

A. Comply with NFPA 70, "National Electrical Code."

1. National Recognized Testing Laboratory (NRTL) Listing: Provide NRTL listed motors.

    a. Term "Listed": As defined in "National Electrical Code," Article 100.
    b. Listing Agency Qualifications NRTL as defined in OSHA Regulation 1910.7.

2. Comply with NEMA MG 1, "Motors and Generators."
3. Motors shall be UL listed.

### 1.4 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.
2. Torque, speed, and horsepower requirements of the load.
3. Ratings and characteristics of supply circuit and required control sequence.
4. Ambient and environmental conditions of installation location.

### 1.5 WARRANTY/GUARANTEE

A. See Division 23 Specification Section "Basic Mechanical Requirements – HVAC" for warranty and guarantee requirements.

## PART 2 - PRODUCTS

### 2.1 GENERAL PRODUCT REQUIREMENTS

A. Equipment Design and Selection: Motors shall be designed and selected, for the intended use, in accordance with the scheduled capacities on the drawings and the requirements of this specification.

### 2.2 MOTOR REQUIREMENTS

A. Compliance: Comply with NEMA MG 1 unless otherwise indicated.

B. Motor Requirements: Requirements below apply to motors covered by this Section except as otherwise indicated.

1. Motors 1 / 2 HP and Larger: Three phase.
2. Motors smaller than 1/2 HP: Single phase.
3. Frequency Rating: 60 Hz.
4. Voltage Rating: Determined by voltage of circuit to which motor is connected for the following motor voltage ratings (utilization voltages):

    a. 120 V Circuit: 115 V - motor rating.
    b. 208 V Circuit: 200 V - motor rating.
    c. 240 V Circuit: 230 V - motor rating.
    d. 480 V Circuit: 460 V - motor rating.

5. Minimum service factor shall be 15% and shall apply at frequency and utilization voltage at which motor is connected. Provide motors which will not operate in service factor range when supply voltage is within 10% of motor voltage rating.
6. Capacity: Sufficient to start and operate connected loads at designated speeds in indicated environment, and with indicated operating sequence, without exceeding nameplate ratings. Provide motors rated for continuous duty at 100% of rated capacity.
7. Temperature Rise: Based on 40ºC ambient except as otherwise indicated.
8. Enclosure: Open drip proof, unless otherwise specified. Provide screen over slots, where slots will permit passage of human extremities.
9. Provide adjustable motor slide base for belt driven equipment. Include adjusting bolts and locknuts.

### 2.3 MOTOR CHARACTERISTICS

A. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.4 THREE PHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Minimum motor efficiencies shall be as follows:

| HP | Percent Efficiency, Minimum |
|---|---|
| 1 and less | 82.5 |
| 1½ | 84.0 |
| 2 | 84.0 |
| 3 | 87.5 |
| 5 | 87.5 |
| 7½ | 89.5 |
| 10 | 89.5 |
| 15 | 91.0 |
| 20 | 91.0 |
| 25 | 92.4 |
| 30 | 92.4 |
| 40 | 93.0 |
| 50 | 93.0 |
| 60 | 93.6 |
| 75 and larger | 94.1 |

C. Service Factor: 1.15.

D. Multispeed Motors: Variable torque.

1. For motors with 2:1 speed ratio, consequent pole, single winding.
2. For motors with other than 2:1 speed ratio, separate winding for each speed.

E. Rotor: Random-wound, squirrel cage.

F. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

G. Temperature Rise: Match insulation rating.

H. Insulation: Class F.

I. Code Letter Designation:

1. Motors 15 HP and Larger: NEMA starting Code F.
2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.

J. Motor Frames: Motor frames constructed of aluminum will not be permitted. Motor frame sizes 184T and larger shall be constructed of cast iron. Motor frames sizes smaller than 184T shall be constructed of rolled steel.

2.5 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

B. Motors Used with Variable Frequency Controllers: Motor ratings, characteristics, and features shall be coordinated with and approved by controller manufacturer.

1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

2.6 SINGLE PHASE MOTORS

A. Motors larger than 1/20 hp shall be one (1) of the following, to suit starting torque and requirements of specific motor application:

1. Permanent-split capacitor.
2. Split phase.
3. Capacitor start, inductor run.
4. Capacitor start, capacitor run.

B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

C. Bearings: Pre lubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

D. Motors 1/20 HP and Smaller: Shaded-pole type.

E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

## PART 3 - EXECUTION

### 3.1 FIELD INSTALLED MOTORS

A. General: The following requirements apply to field-installed motors.

1. Install motors in accordance with manufacturer's published instructions and the following:

a. Direct Drive Motors: Mount securely in accurate alignment. Connect to driven equipment with coupler of appropriate type and material for the given duty. Coupler shall be selected for high and range of motor application.

b. Belt Drive Motors: Use adjustable motor mounting bases. Align pulleys and install belts. Use belts identified by the manufacturer and tension belts in accordance with manufacturer recommendations.

END OF SECTION 230513

# SECTION 230517 – SLEEVES, SLEEVE SEALS, AND ECUTCHEONS FOR HVAC PIPING

First Edition 5-16-2017

(Engineer shall edit specifications and blue text in header to meet project requirements. This includes but is not limited to updating Equipment and/or Material Model Numbers indicated in the specifications and adding any additional specifications that may be required by the project. Also turn off all "Underlines".)

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 23.

### 1.2 SUMMARY

A. Section includes the requirements for pipe sleeves, sleeve seals and escutcheons for piping systems using the following:

1. Pipe sleeves.
2. Sleeve seal systems.
3. Grout.
4. Escutcheons.
5. Floor plates.

### 1.3 ACTION SUBMITTALS

A. Product Data: For each specified product, include manufacturers cut sheets, dimensional data, performance data, installation instructions, specified options, and warranty information.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for sleeves and sleeve seals.

### 1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Include a copy of each approved submittal along with any applicable maintenance data in the project operation and maintenance manual.

### 1.5 WARRANTY/GUARANTEE

A. See Division 23 Specification Section "Basic Mechanical Requirements – HVAC" for warranty and guarantee requirements.

## PART 2 - PRODUCTS

### 2.1 GENERAL PRODUCT REQUIREMENTS

A. Equipment Design and Selection: Pipe sleeves, sleeve seals, and escutcheons shall be designed and selected, for the intended use, in accordance with the requirements of this specification.

B. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. Sleeve Seal Systems:
   a. Advance Products & Systems, Inc.
   b. CALPICO, Inc.
   c. Metraflex Company (The).
   d. Pipeline Seal and Insulator, Inc.
   e. Proco Products, Inc.

### 2.2 PIPE SLEEVES

A. Steel Pipe Sleeves: Steel pipe sleeves shall be standard black steel pipe Type E, Grade B, with plain ends conforming to ASTM A53/A53M.

B. Cast Iron Pipe Sleeves: Cast iron pipe sleeves shall be standard weight cast iron pipe with plain ends conforming to ASTM A74 and CISPI – 301.

### 2.3 SLEEVE SEAL SYSTEMS

A. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

1. Sealing Elements: EPDM-rubber or NBR interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Stainless steel.
3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

### 2.4 GROUT

A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 5,000-psi, twenty eight (28) day compressive strength.

D. Packaging: Premixed and factory packaged.

2.5 ESCUTCHEONS

A. One (1) Piece, Cast-Brass Type, Deep-Pattern Type: With polished, chrome-plated and rough-brass finish and setscrew fastener.

B. One (1) Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.

C. Split-Casting Brass Type: With polished, chrome-plated and rough-brass finish and with concealed hinge and setscrew.

D. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed hinge, and spring-clip fasteners.

2.6 FLOOR PLATES

A. One (1) Piece Floor Plates: Cast-iron flange with holes for fasteners.

B. Split-Casting Floor Plates: Cast brass with concealed hinge.

**PART 3 - EXECUTION**

3.1 GENERAL

A. Install all HVAC System sleeves, escutcheons, and associated components as required in accordance with the applicable codes and the best practices of the industry.

B. The work under this section shall be coordinated with that of all trades so that all work may be installed in the most direct and workmanlike manner and so that interference between piping, ducts, equipment, architectural and structural features will be avoided.

C. Coordinate clearance requirements with CM/GC for piping penetrating walls and floor slabs.

D. Mix grout with clean potable water; if grout is to be in contact with stainless-steel surfaces, use demineralized water.

E. Install accessories that do not corrode or soften in either a wet or dry applications.

3.2 PIPE SLEEVE INSTALLATION

A. For Fire-Rated Assemblies (Floors, Walls, Ceilings):

1. Use standard weight steel pipe or service weight cast iron pipe for pipe sleeves. Where sleeves are installed in load bearing walls, use only standard weight steel pipe for pipe sleeves.
2. Provide a minimum of one half (1/2) inch annular space clearance around the entire circumference of the pipe passing through the sleeve.
3. Center pipe passing through sleeve.
4. Do not continue insulation through sleeve.
5. The entire annular space must be sealed with fire stopping sealant.
6. Seal ends of pipe insulation and butt insulation ends up to fire stopping sealant in sleeve.
7. Sleeves in walls must be installed flush with both finished wall surfaces.
8. Sleeves in floors must be installed with top of sleeve one (1) inch above the finished floor surface. The bottom of the sleeve must be flush with the finished surface of the underside of the floor assembly.
9. In finished areas provide an escutcheon plate around the bare pipe or insulated pipe passing through the assemblies to conceal the sleeve and sealant. If a riser clamp is in place, omit the escutcheon.

B. For Non Fire-Rated Assemblies:

1. Floors:

   a. Use standard weight steel pipe or service weight cast iron pipe for pipe sleeves.
   b. Provide a minimum of one half (1/2) inch annular space clearance around the entire circumference of the pipe passing through the sleeve.
   c. Center pipe passing through sleeve.
   d. Do not continue insulation through sleeve.
   e. The entire annular space must be sealed with waterproof sealant.
   f. Seal ends of pipe insulation and butt insulation ends up to waterproof sealant in sleeve.
   g. Sleeves must be installed with top of sleeve one (1) inch above the finished floor surface. The bottom of the sleeve must be flush with the finished surface of the underside of the floor assembly.
   h. In finished areas provide an escutcheon plate around the bare pipe or insulated pipe passing through the assemblies to conceal the sleeve and sealant. If a riser clamp is in place, omit the escutcheon.

2. Walls:

   a. Use standard weight steel pipe or service weight cast iron pipe for pipe sleeves for masonry walls. Where sleeves are installed in load bearing walls, use only standard weight steel pipe for pipe sleeves in masonry walls.

b. Use standard weight steel or service weight cast iron for pipe sleeve in frame walls.
c. For non-insulated pipes, provide a minimum of one half (1/2) inch annular space clearance around the entire circumference of the pipe passing through the sleeve.
d. For insulated pipes, provide a minimum of one half (1/2) inch annular space clearance around the entire circumference of the insulation.
e. Center insulated pipe passing through sleeve.
f. Continue insulation through sleeve.
g. The entire annular space must be sealed with smoke and acoustic sealant.
h. Sleeves in wall must be installed flush with both finished wall surfaces.
i. In finished areas provide an escutcheon plate around the bare pipe or insulated pipe passing through the assemblies to conceal the sleeve and sealant.

C. Sealant Requirements: Comply with requirements for sealants specified Architectural Specification Section "Joint Sealants".

D. Fire-Barrier Penetrations: Comply with requirements for firestopping specified in Architectural Specification Section "Penetration Firestopping".

## 3.3 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

## 3.4 ECUTCHEONS INSTALLATION

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of insulated piping and with OD that completely covers opening.

C. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. New Piping: One (1) piece, floor-plate type.
2. Existing Piping: Split-casting, floor-plate type.

END OF SECTION 230517

# SECTION 230519 – METERS AND GAUGES FOR HVAC PIPING

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 23.

### 1.2 SUMMARY

A. This section includes the requirements for thermometers, and gauges using the following:

1. Vapor actuated thermometers.
2. Liquid-in-glass thermometers.
3. Thermowells.
4. Dial-type pressure gauges.
5. Gauge attachments.
6. Test plugs.

### 1.3 ACTION SUBMITTALS

A. Product Data: For each specified product, include manufacturers cut sheets, dimensional data, performance data, installation instructions, specified options, and warranty information.

### 1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of meter and gage, from manufacturer.

### 1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Include a copy of each approved submittal along with any applicable maintenance data in the project operation and maintenance manual.

### 1.6 WARRANTY/GUARANTEE

A. See Division 23 Specification Section “Basic Mechanical Requirements – HVAC” for warranty and guarantee requirements.

## PART 2 - PRODUCTS

### 2.1 GENERAL PRODUCT REQUIREMENTS

A. Equipment Design and Selection: Meters and gauges shall be designed and selected, for the intended use, in accordance with the requirements of this specification.

B. Acceptable Manufacturers: Subject to compliance with requirements, provide one (1) of the following:

1. Thermometers:
   a. Trerice, H.O. Company.
   b. Weiss Instruments, Inc.
   c. Weksler Instrument Corp.

2. Pressure Gauges:
   a. Trerice, H.O. Company.
   b. Weiss Instruments, Inc.
   c. Weksler Instrument Corp.

3. Test Plugs:
   a. Trerice, H.O. Company.
   b. Flow Design Inc.
   c. Peterson Equipment Company Inc.

## 2.2 THERMOMETERS

A. General Requirements:

1. Thermometers shall be either vapor actuated or liquid in glass type thermometers suitable for direct or remote mount installation as specified. Provide thermometers were indicated on the drawings and details.

2. Service and Scale Range:

   a. Chilled Water: 0ºF to 100ºF, with two (2) degree scale divisions.

B. Direct-Mounted, Metal-Case, Vapor-Actuated Thermometers: Use direct mounted vapor actuated type thermometers as indicated below:

1. Standard: ASME B40.200.
2. Case: Sealed type, cast aluminum or drawn steel four and one half (4-1/2) inch nominal diameter.
3. Element: Bourdon tube or other type of pressure element.
4. Movement: Brass, precision geared.
5. Dial: Nonreflective aluminum with permanently etched scale markings graduated in ºF.
6. Pointer: Dark-colored metal.
7. Window: Glass

8. Ring: Metal.
9. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.

    a. Design for Thermowell Installation: Bare stem.

10. Accuracy: +/-1% of scale range.

C. Remote-Mounted, Metal-Case, Vapor-Actuated Thermometers: Use remote mounted vapor actuated type thermometers as indicated below:

1. Standard: ASME B40.200.
2. Case: Sealed type, cast aluminum or drawn steel four and one half (4-1/2) inch nominal diameter with back flange and holes for panel mounting.
3. Element: Bourdon tube or other type of pressure element.
4. Movement: Mechanical, with link to pressure element and connection to pointer.
5. Dial: Nonreflective aluminum with permanently etched scale markings graduated in ºF.
6. Pointer: Dark-colored metal.
7. Window: Glass.
8. Ring: Metal.
9. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.

    a. Design for Thermowell Installation: Bare stem.

10. Accuracy: Plus or minus one (1) percent of scale range.

D. Liquid-in-Glass Metal-Case, Industrial-Style Thermometers: Use liquid-in-glass type thermometers as indicated below:

1. Standard: ASME B40.200.
2. Case: Cast aluminum; nine (9) inches nominal size unless otherwise indicated.
3. Case Form: Adjustable angle unless otherwise indicated.
4. Tube: Glass with magnifying lens and red organic liquid.
5. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in ºF.
6. Window: Glass.
7. Stem: Copper-plated steel, aluminum, or brass for a separable and of length to suit installation.

    a. Design for Thermowell Installation: Bare stem.

8. Accuracy: +/-1% of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.3 THERMOWELLS

A. Thermowells:

1. Standard: ASME B40.200.
2. Description: Brass or stainless-steel thermometer well.
3. Pressure Rating: Not less than piping system design pressure.
4. Stem length: To extend two (2) inches into fluid or center of pipe, whichever, is shorter.
5. Extension for Insulated Piping: Two (2) inches nominal, but not less than thickness of insulation.
6. Threaded Cap Nut: With chain permanently fastened to well and cap.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.4 PRESSURE GAUGES

A. General Requirements:

1. Provide pressure gauges were indicated on the drawings and as specified.
2. Service and Scale Range in pounds per square inch (PSI):

    a. HVAC Water Systems: Zero (0) to two (2) times operating pressure.
    b. Steam Systems: 0 to 100 psig, with ten (10) figure intervals with 1 psi scale divisions.

3. Standard: ASME B40.100.
4. Case: Liquid-filled type; cast aluminum or drawn steel; four and one half (4-1/2) inch nominal diameter.
5. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
6. Match pressure connection size in first subparagraph below with gauge attachment size.
7. Pressure Connection: Brass, with NPS 1/4, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
8. Movement: Mechanical, with link to pressure element and connection to pointer.
9. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
10. Pointer: Dark-colored metal.
11. Window: Glass.
12. Ring: Metal.
13. Accuracy: Grade A, +/- 1% of scale range.

B. Gage Attachments: Provide gage attachments as indicated below:

1. Syphons: One quarter (1/4) inch straight coil of brass tubing with threads on each end.

2. Gauge Valves: Provide gauge valves (specialty valves) as specified in Division 23 Specification Section "Valves for HVAC Piping Systems".

2.5 TEST PLUGS

A. Description: Nickel plated brass body test plug in one half (1/2) inch fitting.

B. Body: Length as required to extend beyond insulation.

C. Pressure Rating: 500 psig minimum.

D. Core Inserts: Two (2) self-sealing valve types, suitable for inserting a one eighth (1/8) inch (3mm) outside-diameter probe from a dial thermometer or pressure gage.

E. Core Material: According to the following for fluid and temperature range:

1. Air, Water, Glycol Oil, and Gas: 20ºF to 200ºF, neoprene rubber.
2. Air and Water: -30°F to 275°F (-35°C to 136°C), ethylene-propylene-diene-terpolymer (EDPM) rubber.

F. Test Plug Cap: Gasketed and threaded cap, with retention chain.

G. Test Kit: Provide test kit consisting of one (1) pressure gage and gage adapter with probe, two (2) bimetal dial thermometers and a carrying case

H. Pressure Gage and Thermometer Ranges: Approximately two (2) times systems operating conditions.

I. Body: Length as required to extend beyond insulation.

**PART 3 - EXECUTION**

3.1 INSTALLATION

A. Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of meters and gauges in the HVAC piping systems. So far as practical, install meters and gauges as indicated.

3.2 THERMOMETERS

A. Install direct-mounted thermometers in thermowells at the most readable position and adjust vertical and tilted positions.

B. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing and support tubing to prevent kinks. Use minimum tubing length.

C. Install thermometers in the following locations:

1. Inlet and outlet of each AHU.

D. For thermometer valves see Division 23 Specification Section “Valves for HVAC Piping Systems”.

3.3 THERMOWELLS

A. Install thermowells with socket extending a minimum of two (2) inches into fluid or center of pipe, whichever is shorter.

B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium.

3.4 PRESSURE GAUGES

A. Install pressure gauges in the following locations:

1. Inlet and outlet of each AHU.

B. Install direct-mounted pressure gauges in piping tees with pressure gage located on pipe at the most readable position.

C. Install remote-mounted pressure gauges on panel.

D. For gage valves see Division 23 Specification Section “Valves for HVAC Piping Systems”.

E. Install test plugs in piping tees.

3.5 CONNECTIONS

A. Install thermometers and gauges adjacent to machines and equipment to allow service and maintenance of thermometers, gauges, machines, and equipment.

B. Install gauges adjacent to machines and equipment to allow servicing and maintenance.

3.6 ADJUSTING

A. Adjust faces of thermometers and gauges to proper angle for best visibility.

B. Adjusting: Adjust faces of thermometers and gauges to proper angle for best visibility.

C. Cleaning: Clean windows of thermometers and gauges and factory finished surfaces. Replace cracked and broken windows and repair scratched and marred surfaces with manufacturer's touchup paint.

END OF SECTION 230519

SECTION **230523** – **VALVES FOR HVAC PIPING SYSTEMS**

PART 1 - GENERAL

PART 2 -

2.1 RELATED DOCUMENTS

2.2

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 23.

A.

2.3 SUMMARY

A. This section includes the requirements for shutoff, drain, specialty, and check valves installed in HVAC piping systems as follows:

1. Hydronic ball valves.
2. Hydronic butterfly valves.
3. Hydronic check valves.
4. Hydronic special valves.
5. Refrigerant system valves.

B.

2.4 ACTION SUBMITTALS

A. Product Data: For each specified product, include manufacturers cut sheets, dimensional data, performance data, installation instructions, finishes, specified options, and warranty information. Identify valves for each HVAC system application.

1.

2.5 CLOSEOUT SUBMITTALS

1.

B. Operation and Maintenance Data: Include a copy of each approved submittal along with any applicable maintenance data in the project operation and maintenance manual.

C.

D. In addition to the approved submittals, for each valve type, include the manufacturers printed exploded view type parts and material list indicating how to dismantle, repair and reassemble the valve, and identifying each part.

1.

2.6 QUALITY ASSURANCE

2.7

A. Installer Qualifications: The installer shall be a qualified licensed installer within the jurisdiction and familiar with the installation of the valves specified herein for each piping system.

B. Compliance: Comply with the following:

1.
2. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
3. ASME B31.1 for power piping valves.
4. ASME B31.9 for building services piping valves.
5.

C. ProPress Valve Compliance: Valves in propress piping systems shall be in compliance with ASME B31.9 for building service piping valves.

D.

E. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

1.

2.8 PERFORMANCE REQUIREMENTS

2.9

A. Compatibility: Products shall be suitable for piping service fluids, materials, working pressures, and temperatures.

B.

2.10 DELIVERY, STORAGE, AND HANDLING

A. Information in this article is paraphrased from MSS.

B. Prepare valves for shipping as follows:

1.
2. Protect internal parts against rust and corrosion.

3. Protect threads, flange faces, grooves, and weld ends.
4. Set ball and plug valves open to minimize exposure of functional surfaces.
5. Set butterfly valves closed or slightly open.
6. Block check valves in either closed or open position.

C. Use the following precautions during storage:

1.
2. Maintain valve end protection.
3. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

D. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use hand wheels or stems as lifting or rigging points.

E.

2.11 WARRANTY/GUARANTEE

2.12

A. See Division 23 Specification Section "Basic Mechanical Requirements – HVAC" for warranty and guarantee requirements.

B.

PART 3 - PRODUCTS

PART 4 -

4.1 GENERAL PRODUCT REQUIREMENTS

4.2

A. Equipment Design and Selection: Valves shall be designed and selected, for the intended use, in accordance with the requirements of this specification.

B.

C. Acceptable Manufacturers: Subject to compliance with requirements, provide lead free plumbing valves by one (1) of the following:

1. Ball Valves – Copper and Steel Piping Systems:
   a. Apollo.
   b. Milwaukee.

c. Watts.
d. Nibco.
e. Viega.

D.

1. Butterfly Valves – Copper and Steel Piping Systems:
   a. ABZ.
   b. Milwaukee.
   c. Bray.
   d.
2. Check Valves – Copper and Steel Piping Systems:
   a. Apollo.
   b. Milwaukee.
   c. Watts.
   d.
3. Special Valves:
   a. Watts.
   b. Spence.
   c. Wilkens.
   d.
4. Refrigerant System Valves:
   a. Mueller Refrigeration Products.
   b. Danfoss Refrigeration Products.
   c. Parker Refrigeration Products.
   d.

E. See shut off, drain, & specialty valve application below for required valves.

F. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

G. Valve Sizes: Same as upstream/downstream piping unless otherwise indicated.

H. Valve Actuator Types:

1.
2. Gear Actuator: For quarter-turn valves NPS 8 and larger.
3. Hand wheel: For valves other than quarter-turn types.
4. Hand lever: For quarter-turn valves NPS 6 and smaller.

I. Valves in Insulated Piping: With two (2) inch stem extensions and the following features:

1.
2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
3. Butterfly Valves: With extended neck.

J. Valve-End Connections:

1.

2. Threaded Ball Valves: With threads according to ASME B1.20.1.
3. Flanged Butterfly Valves: With flanges according to ASME B16.1 for iron valves.
4. Press End Ball Valves: Where pro press piping systems are used.

K. Provide chain operators in place of valve handles for valves installed in piping systems ten (10) feet or higher above the finished floor of mechanical equipment rooms.

4.3 SHUT OFF, DRAIN, AND SPECIALITY VALVE APPLICATIONS

4.4

A. General Application: All Valves installed in HVAC Systems shall be as specified below. For this application, HVAC Piping Systems and Specialty Valves are defined as follows:

1.
2. HVAC Water Piping Systems: Includes Chilled Water, Piping utilizing solder joint, pro press joint and/or flanged joint methods.
3. Specialty Valves: Valves used at connections for P/T Plugs, DP Switches, & Pressure Gages utilizing solder joint, screw joint and/or pro press joint methods.
4. Special Valves: Used as solenoid valves, pressure reducing valves, pressure/temperature/relief valves, safety relief valves, and pressure regulating valves.
5. Refrigerant System Valves: Used as diaphragm valves, check valves, service valves, solenoid valves, safety relief valves, thermal expansion valves, and hot gas bypass valves.

B. Shut Off, Drain and Specialty Valves – UMB Campus: Gate Valves will not be permitted for installation in these systems. Only listed manufacturers and model numbers below are acceptable to UMB.

C.

1. Shut Off Valves for HVAC Water Solder Joint Piping Systems One Half (1/2) Inch to Two (2) Inch: Use Two (2) Piece Full Port Ball Valves and Trim as indicated below:
2.
   a. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
   b.
      1) Apollo: 77F-140 Series, Brass Body.
      2) Milwaukee Valve Company: BA400S, Bronze Body.
      3) Watts Water Technologies: FVB-3C-SS, Brass Body.
      4) Nibco: T585-80-66, Bronze Body.
   c.
   d. Description:
   e.
      1) Standard: MSS SP-110.
      2) SWP Rating: 150 psig.
      3) CWP Rating: 600 psig.
      4) Body Design: Two piece.
      5) Body Material: Bronze or Brass.
      6) Ends: Threaded.

7) Seats: Modified Teflon double seal seats and Teflon seals.
8) Stem: Type 316 Stainless steel.
9) Ball: Type 316 Stainless steel, vented.
10) Port: Full.
11) Handle: Lever Type.
12) For valves used as combination balancing/shut off duty on HVAC systems, provide memory stops.

f.

3. Shut Off Valves for HVAC Water ProPress Piping Systems One Half (1/2) Inch to One and One Quarter (1-1/4) Inch: Use Two (2) Piece Full Port Ball Valves and Trim as indicated below:

D.

a. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

b.

1) Viega: 2970.3, Bronze Body
2) Conbraco Industries, Inc. Apolloxpress 77W-140, Bronze Body.
3) Milwaukee: BA480S, Brass Body.

c.

d. Description:

e.

1) Standard: MSS SP-110.
2) SWP Rating: 150 psig.
3) CWP Rating: 600 psig.
4) Body Design: Two (2) piece.
5) Body Material: Bronze.
6) Ends: Press ends, smart connect feature.
7) Seats: EPDM
8) Stem: Type 316 Stainless steel.
9) Ball: Type 316 Stainless steel, vented.
10) Port: Full.
11) Handle: Lever Type.
12) For valves used as combination balancing/shut off duty on HWR systems, provide memory stops.
13)

2. Shut Off Valves for HVAC Water ProPress Piping Systems One and One Half (1-1/2) Inch to Two (2) Inch: Use Two (2) Piece Full Port Ball Valves and Trim as indicated below:

E.

a. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

b.

1) Viega: 2970.3, Bronze Body.
2) Conbraco Industries, Inc. Apolloxpress 77W-140, Bronze Body.
3) Milwaukee: BA480S, Brass Body.

c.

d. Description:

e.

1) Standard: MSS SP-110.
2) SWP Rating: 150 psig.
3) CWP Rating: 600 psig.
4) Body Design: Two (2) piece.
5) Body Material: Bronze.
6) Ends: Press ends, smart connect feature.
7) Seats: EPDM
8) Stem: Type 316 Stainless steel.
9) Ball: Type 316 Stainless steel, vented.
10) Port: Full.
11) Handle: Lever Type.
12) For valves used as combination balancing/shut off duty provide memory stops.

2.

3. Shut Off Valves for HVAC Water Flanged, Victaulic and/or Welded Joint Piping Systems Two and One half (2-1/2) and Larger: Use Bi-directional dead end service high performance butterfly valve as indicated below.

4.

a. Manufacturers: Subject to compliance with requirements, provide products by products by one (1) of the following:

b.

1) ABZ - 402 – 100 – DDE.
2) Bray Series 41 with trim 466.
3) DeZurik BHPLICS2S5FTTTLT.
4) Milwaukee – HP1LES4211.

c.

d. Description:

e.

1) Standard: MSS SP-68.
2) CWP Rating: 285 psig at 100ºF
3) Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
4) Body Material: Carbon steel.
5) Seat: modifies Teflon double seal seats and Teflon seals.
6) Stem: Stainless steel; offset from seat plane.
7) Disc: 316 Stainless steel.
8) Service: Bidirectional.
9) For valves used as combination balancing/shut off duty on HVAC systems, provide memory stops.

f.

5. Drain Valves for HVAC Water Solder Joint Piping Systems One half (1/2) to Two (2) Inch: Use three quarter (3/4 x 3/4) Inch, Two (2) Piece Full Port Ball Valves and Trim as indicated below:

6.

a. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

b.

1) Apollo: 77F-140 Series, Brass Body.
2) Milwaukee Valve Company: BA400S Series, Bronze Body.
3) Watts Water Technologies: FVB-3C-SS, Brass Body.
4) Nibco: T585-80-66, Bronze Body.

7.

a. Description:

b.

1) Standard: MSS SP-110.
2) SWP Rating: 150 psig.
3) Body Design: Two piece.
4) Body Material: Bronze.
5) Ends: Threaded.
6) Seats: Modified Teflon double seal seats and Teflon seals.
7) Stem: Type 316 Stainless steel.
8) Ball: Type 316 Stainless steel.
9) Port: Full.
10) Handle: Lever Type.
11) Capped hose connection.
12)

8. Drain Valves HVAC Water Flanged, Victaulic and/or Welded Joint Piping Systems Two and One Half (2-1/2) Inch and Larger: Use Two and One Half (2-1/2) Inch, Two (2) Piece Full Port Ball Valves and Trim as indicated below:

9.

a. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

b.

1) Apollo: 77F-140 Series, Brass Body.
2) Milwaukee Valve Company: BA400S Series, Bronze Body.
3) Watts Water Technologies: FVB-3C-SS, Brass Body.
4) Nibco: T585-80-66, Bronze Body.

10.

a. Description:

b.

1) Standard: MSS SP-110.
2) SWP Rating: 150 psig.
3) Body Design: Two piece.
4) Body Material: Bronze.
5) Ends: Threaded.
6) Seats: Modified Teflon double seal seats and Teflon seals.
7) Stem: Type 316 Stainless steel.
8) Ball: Type 316 Stainless steel.
9) Port: Full.
10) Handle: Lever Type.
11) Two and One Half (2-1/2) inch capped fire hose connection.

12)

11. Drain Valves for HVAC Water ProPress Piping Systems One Half (1/2) Inch to Two (2) Inch: Use Two (2) Piece Full Port Ball Valves and Trim as indicated below:
12.
    a. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
    b.
        1) Viega: 2970.3, Bronze Body
        2) Conbraco Industries, Inc. Apolloxpress 77W-140
        3) Milwaukee: BA480S
    c.
    d. Description:
    e.
        1) Standard: MSS SP-110.
        2) SWP Rating: 150 psig.
        3) CWP Rating: 600 psig.
        4) Body Design: Two (2) piece.
        5) Body Material: Bronze.
        6) Ends: Press ends, smart connect feature.
        7) Seats: EPDM
        8) Stem: Type 316 Stainless steel.
        9) Ball: Type 316 Stainless steel, vented.
        10) Port: Full.
        11) Handle: Lever Type.
13.
14. Specialty Valves for HVAC Water Solder Joint Piping Systems One Half (1/2) Inch to Two (2) Inch: Use Two (2) Piece Full Port Ball Valves and Trim as indicated below:
15.
    a. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
    b.
        1) Apollo: 77F-140.
        2) Milwaukee Valve Company: BA400S.
        3) Watts Water Technologies: FVB-3C-SS.
        4) Nibco: T585-80-66
    c.
    d. Description:
    e.
        1) Standard: MSS SP-110.
        2) SWP Rating: 150 psig.
        3) CWP Rating: 600 psig.
        4) Body Design: Two piece.
        5) Body Material: Bronze or Brass.
        6) Ends: Threaded.
        7) Seats: Modified Teflon double seal seats and Teflon seals.
        8) Stem: Type 316 Stainless steel.
        9) Ball: Type 316 Stainless steel, vented.

10) Port: Full.
11) Handle: Lever Type.

16.

17. Specialty Valves for HVAC Water Threaded, Flanged, Victaulic, and/or Welded Joint Piping Systems Two and One Half (2-1/2) Inch and Larger: Use One Half (1/2) Inch, Two (2) Piece Full Port Ball Valves and Trim as indicated below:

18.

a. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

b.

1) Apollo: 77F-140.
2) Milwaukee Valve Company: BA400S.
3) Watts Water Technologies: FVB-3C-SS.
4) Nibco: T585-80-66

c.

d. Description:

e.

1) Standard: MSS SP-110.
2) SWP Rating: 150 psig.
3) CWP Rating: 600 psig.
4) Body Design: Two piece.
5) Body Material: Bronze or Brass.
6) Ends: Threaded.
7) Seats: Modified Teflon double seal seats and Teflon seals.
8) Stem: Type 316 Stainless steel.
9) Ball: Type 316 Stainless steel, vented.
10) Port: Full.
11) Handle: Lever Type.

19.

20. Specialty Valves for HVAC Water ProPress Piping Systems One Half (1/2) Inch to Two (2) Inch: Use One Half (1/2) Inch, Two (2) Piece Full Port Ball Valves and Trim as indicated below:

21.

a. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

b.

1) Viega: 2970.3, Bronze Body
2) Conbraco Industries, Inc. Apolloxpress 77W-140
3) Milwaukee: BA480S

c.

d. Description:

e.

1) Standard: MSS SP-110.
2) SWP Rating: 150 psig.
3) CWP Rating: 600 psig.
4) Body Design: Two (2) piece.
5) Body Material: Bronze.

6) Ends: Press ends, smart connect feature.
7) Seats: EPDM
8) Stem: Type 316 Stainless steel.
9) Ball: Type 316 Stainless steel, vented.
10) Port: Full.
11) Handle: Lever Type.

22.

4.5 CHECK VALVES

A. Two and One half (2-1/2) inches and smaller use – Bronze Lift Check Valves as indicated below:

B.

1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
   a.
   b. Apollo
   c. Milwaukee Valve Company.
   d. Watts.
2.
3. Description:
   a.
   b. Standard: MSS SP-80, Type 3.
   c. CWP Rating: 200 psig.
   d. Body Design: Horizontal flow.
   e. Body Material: ASTM B 62, bronze.
   f. Ends: Threaded.
   g. Disc: Bronze.
   h.

C. Three (3) inches and Larger – Use Bronze Lift Check Valves as indicated below:

1.
2. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
   a.
   b. Milwaukee Valve Company.
   c. Watts Regulator Co.
   d.
3. Description:
   a.
   b. Standard: MSS SP-71, Type I.
   c. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
   d. NPS 14 to NPS 24, CWP Rating: 150 psig.
   e. Body Design: Clear or full waterway.
   f. Body Material: ASTM A 126, gray iron with bolted bonnet.
   g. Ends: Flanged.
   h. Trim: Bronze.

i. Gasket: Asbestos free.

D. Bronze Lift Check Valves – Use Class 125, Lift Check Valves with Bronze Disc as indicated below:

1.
2. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
3.
   a. Crane Co.; Crane Valve Group; Crane Valves.
   b. Crane Co.; Crane Valve Group; Jenkins Valves.
   c. Crane Co.; Crane Valve Group; Stockham Division.
   d.
4. Description:
   a.
   b. Standard: MSS SP-80, Type 1.
   c. CWP Rating: 200 psig.
   d. Body Design: Vertical or horizontal flow.
   e. Body Material: ASTM B 61 or ASTM B 62, bronze.
   f. Ends: Threaded.
   g. Disc: Bronze or Buna rubber with stainless steel holder threaded or soldered end connections.
   h.

## 4.6 SPECIAL VALVES

A. Solenoid Valves: Aluminum body, 120 volts AC, 60 Hz, Class B continuous duty molded coil; NEMA 4 coil enclosure; electrically opened/electrically closed; dual coils; normally closed; UL and FM approved and labeled.

B. Safety Relief Valves:

1. 125 psig working pressure and 250ºF maximum operating temperature; designed, manufactured, tested, and labeled in accordance with the requirements of Section IV of the ASME Boiler and Pressure Vessel Code.
2. Valve body shall be cast-iron.
3. Valve shall have forged copper alloy disc, fully enclosed cadmium plated steel spring with adjustable pressure range and positive shut-off.
4. Factory set valves to relieve at 10 psi above operating pressure.

C. Combined Pressure/Temperature Relief Valves:

1. Hydronic Systems: diaphragm operated, cast-iron or brass body valve, with low inlet pressure check valve, inlet strainer removable without system shut-down, and noncorrosive valve seat and stem. Select valve size, capacity, and operating pressure to suit system. Valve shall be factory-set at operating pressure and have the capability for field adjustment. Safety relief valve designed, manufactured, tested, and labeled in accordance with the requirements of Section IV of the ASME Boiler and Pressure Vessel Code. Valve body shall be cast-iron, with all wetted internal working parts made of brass and rubber;

125 psig working pressure and 250ºF maximum operating temperature. Select valve to suit actual system pressure and Btu capacity. Provide with fast fill feature for filling hydronic system.

D. Pressure-Regulating Valves - Hydronic Systems:

1. Single-seated, direct-operated type, having bronze body with integral strainer and complying with requirements of ASSE Standard 1003. Select proper size for maximum flow rate and inlet and outlet pressures indicated.
2. Prefabricated reducing systems with shut-off valves shall be permitted; however, shut-off valves shall be as specified herein, and unions shall be provided for removal of regulator.

a.

## 4.7 REFRIGERANT SYSTEM VALVES

A. Diaphragm Packless Valves:

1. Body and Bonnet: Cast bronze; globe design with straight-through or angle pattern.
2. Diaphragm: Phosphor bronze and stainless steel with stainless-steel spring.
3. Operator: Rising stem and hand wheel.
4. Seat: Nylon.
5. End Connections: Socket, union, or flanged.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 275°F.

B. Check Valves:

1. Body: Ductile iron, forged brass, or cast bronze; globe pattern.
2. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.
3. Piston: Removable polytetrafluoroethylene seat.
4. Closing Spring: Stainless steel.
5. Retain first subparagraph below for optional manual opening feature.
6. Manual Opening Stem: Seal cap, plated-steel stem, and graphite seal.
7. End Connections: Socket, union, threaded, or flanged.
8. Maximum Opening Pressure: 0.50 psig.
9. Working Pressure Rating: 500 psig.
10. Maximum Operating Temperature: 275°F.

C. Service Valves:

1. Body: Forged brass with brass cap including key end to remove core.
2. Core: Removable ball-type check valve with stainless-steel spring.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Copper spring.
5. Working Pressure Rating: 500 psig.

D. Solenoid Valves: Comply with ARI 760 and UL 429; listed and labeled by an NRTL.

1. Body and Bonnet: Plated steel.
2. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Threaded.
5. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and 115-V ac coil.
6. Working Pressure Rating: 400 psig.
7. Maximum Operating Temperature: 240°F.
8. Subparagraph below is an optional feature.
9. Manual operator.

E. Safety Relief Valves: Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.

1. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
2. Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Seat Disc: Polytetrafluoroethylene.
4. End Connections: Threaded.
5. Working Pressure Rating: 400 psig.
6. Maximum Operating Temperature: 240°F.

F. Thermostatic Expansion Valves: Comply with ARI 750.

1. Body, Bonnet, and Seal Cap: Forged brass or steel.
2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Packing and Gaskets: Non-asbestos.
4. Capillary and Bulb: Copper tubing filled with refrigerant charge.
5. Suction Temperature: 40°F.
6. Superheat: Adjustable.
7. Reverse-flow option (for heat-pump applications).
8. End Connections: Socket, flare, or threaded union.
9. Working Pressure Rating: 450 psig.

G. Hot-Gas Bypass Valves: Comply with UL 429; listed and labeled by an NRTL.

1. Body, Bonnet, and Seal Cap: Ductile iron or steel.
2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Packing and Gaskets: Non-asbestos.
4. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
5. Seat: Polytetrafluoroethylene.
6. Equalizer: Internal.
7. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and 115-V ac coil.
8. End Connections: Socket.
9. Throttling Range: Maximum 5 psig.
10. Working Pressure Rating: 500 psig.
11. Maximum Operating Temperature: 240°F.

PART 5 - EXECUTION

PART 6 -

6.1 GENERAL

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

F.

6.2 VALVE INSTALLATION

A. Valves shall be placed in such manner as to be easily accessible for smooth and easy hand wheel operation and packing maintenance.

B. Install valves in piping where shown and where listed herein:

1.
2. To balance flows in water piping systems.
3. To isolate all items of equipment.
4. To isolate motorized flow control valves.
5. To isolate branch lines and risers at mains.
6. To drain low points in piping systems.
7. To drain pipe risers.
8. To drain equipment.
9. To drain trapped sections in the piping system.

C. Where piping or equipment may be subsequently remove, provide valves with bodies having integral flanges or full lugs drilled and tapped to hold valve in place so that downstream piping or equipment can be disconnected and replaced with blank-off plate while valve is still in service.

D. Valves for equipment and controls shall be installed full size of pipe before reducing size to make equipment connection.

E. Where there is no interference, shut-off valves shall be installed with handwheel up on horizontal runs of pipe to prevent accumulation of foreign matter in working parts of valves. In no case shall the stem be installed below the pipe centerline.

F. On valves, strainers, etc., installed in copper piping, provide a union on the discharge side of each valve and threaded adapters where copper piping connects to valves, strainers, etc.

G. Drawings indicate the general arrangement of piping, fittings, and specialties.

H. Install valves with unions or flanges at each piece of equipment arranged to allow servicing, maintenance, and equipment removal without system shutdown.

I. Install valves in a position to allow full handle movement.

J. Install safety relief valves on hot water generators, boilers, pressure vessels, etc. and elsewhere as required by ASME Boiler and Pressure Vessel Code. Pipe discharge without valves as shown on drawings, or to nearest floor drain if not shown on drawings. Comply with ASME Boiler and Pressure Vessel Code Section VIII, Division 1 for installation, requirements.

K. Install shut-off valves upstream and downstream of each pressure regulator.

L. Where threaded ball valves are installed in brazed copper piping systems braze each threaded adapter on to the piping. After each adapter has cooled to the touch install the threaded ball valve. Do not connect the threaded adapter to the valve and then braze the adapter and valve to the piping as this will result in damage to the valve seals. If any valve, in the brazed piping systems are damaged due to faulty installation the damaged valves shall be replaced by the contractor at no cost to the University.

M. Where butterfly valves are installed in copper piping systems provide companion flanges and dielectric gasket kits for each flange. When valves and/or fittings are installed in piping where electrolysis may occur provide dielectric unions at each connection.

N. Locate valves for easy access and provide separate support where necessary.

O. Install valves in horizontal piping with stem at or above center of pipe.

P. Install valves in position to allow full stem movement.

Q. Install chain wheels on operators for ball and butterfly valves four (4) inches and larger and more than ten (10) feet above floor. Extend chains to sixty (60) inches above finished floor. This requirement is limited to mechanical equipment rooms only.

R. Install check valves for proper direction of flow and as follows:

1.
2. Swing Check Valves: In horizontal position with hinge pin level.
3. Lift Check Valves: With stem upright and plumb.
4.

6.3 SPECIAL VALVE APPLICATIONS

A. Install pressure relief valves and temperature/pressure relief valves where indicated on the drawings and where required for proper system operation.

B. Install calibrated-orifice, balancing valves in the return pipe of each heating or cooling terminal and AHU coil.

6.4

6.5 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

B.

6.6 THREADED CONNECTIONS

A. Note the internal length of threads in valve ends and proximity of valve internal seat or wall to determine how far pipe should be threaded into valve.

B.

C. Align threads at point of assembly.

D.

E. Apply appropriate tape or thread compound to the external pipe threads, except where dry seal threading is specified.

F. Assemble joint, wrench tight. Wrench on valve shall be on the valve end into which the pipe is being threaded.

G.

6.7 FLANGED CONNECTIONS

A. Align flange surfaces parallel.

B. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly with a torque wrench.

C. For dead-end service, butterfly valves require flanges both upstream and downstream for proper shutoff and retention.

D.

6.8 PRESS END CONNECTIONS

A.

B. Press connections shall be made according to the manufacturer's installation instructions.

C.

D. Where thread end valves are installed in press end piping systems, provide threaded adaptors for each valve and follow manufacturer's installation instructions.

E. Where flanged valves are installed in press end piping systems, provide flange connections for each valve and follow manufacturer's installation instructions.

F.

6.9 REFRIGERANT VALVE APPLICATIONS

6.10

A. Install diaphragm packless valves in suction and discharge lines of compressor.

B.

C. Install service valves for gauge taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.

D. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.

E.

F. Except as otherwise indicated, install diaphragm packless valves on inlet and outlet side of filter dryers.

G.

H. Install a full-sized, three-valve bypass around filter dryers.

I. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top.

J.

K. Install thermostatic expansion valves as close as possible to distributors on evaporators.

1. Install valve so diaphragm case is warmer than bulb.
2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.

L. Install safety relief valves where required by ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.

END OF SECTION 220523

# SECTION 230529 – HANGERS AND SUPPORTS FOR HVAC SYSTEMS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 23.

### 1.2 SUMMARY

A. This section includes the requirements for hangers and supports for HVAC piping and equipment as follows:

1. Metal pipe angers and supports.
2. Trapeze pipe hangers.
3. Thermal hanger shield inserts.
4. Fastener systems.
5. Pipe stands.
6. Pipe positioning system.
7. Miscellaneous materials.

### 1.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
3. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.
4. Support for all conditions of operation, including variations in installed and operating weight of equipment, piping and ductwork, to prevent excess stress and allow for proper expansion and contraction.

C. Support materials shall be steel or stainless steel unless specifically indicated.

D. Support devices shall be factory fabricated by manufacturers and have published load ratings.

E. Unless otherwise indicated, design structural support members and support devices, including couplings, rods, trapeze supports and strut systems, with safety factor in accordance with AISC Manual of Steel Construction, but not less than 2.0.

F. Unless otherwise indicated, hangers, support devices and hardware shall be steel and shall have factory standard black, primed, galvanized or electroplated finish for indoor application, and hot-dipped galvanized finish for outdoor application and corrosive atmospheres. Coat cut edges, welds or any damaged finish with galvanized paint.

G. Material in contact with pipe shall be compatible with piping material so that neither shall have deteriorating action on the other. If materials such as copper, stainless steel or other materials are not compatible, provide nonmetallic separation between uninsulated piping and metal supports. Plastic coated steel supports are acceptable.

H. Unless otherwise indicated, steel support devices exposed to ventilation air stream shall be stainless steel or steel with either galvanized finish or paint finish.

I. Fiberglass piping system supports shall meet the more stringent of (a) the requirements of these specifications and (b) the piping manufacturer's recommendations.

J. Contractor is responsible for proper placement and sizing of supporting devices to accommodate insulation thickness and pitching of pipe. Coordinate with Contractor performing work specified in Section "Insulation for HVAC Pipe and Duct Systems".

K. Where piping can be conveniently grouped to allow trapeze type supports, supporting steel shall be by means of standard structural shapes.

L. Hangers and rods shall be plumb when pipelines are at their normal operating temperatures.

M. Unless otherwise indicated, continuous insert channels are not allowed.

N. Punching, drilling, or welding of building structural steel is not allowed unless approved by Structural Engineer.

O. Application of concrete inserts and concrete anchors shall be reviewed and approved by Structural Engineer prior to installation.

P. Lateral bracing for piping and equipment shall be reviewed and approved by Structural Engineer prior to installation. Lateral braces shall be designed and detailed to apply loads as directly as possible to structural floor slabs, roof decks, or other building lateral

elements. Braces shall not be applied to bottom flanges of steel beams or bottom chords of steel joists.

Q. Any proposed weld attachments to building structure shall be reviewed by Structural Engineer prior to execution of work. This review may result in use of other welding codes or standards, which may apply to "structural work". Execution of this work may be assigned to General Trades responsible for building structural steel. Cost for this work, however, will remain the responsibility of this Contractor.

R. Fasteners including concrete anchors for seismic application shall have ICC Evaluation Service Report (ESR) and meet requirements of local authorities.

1.4 ACTION SUBMITTALS

A. Product Data: For each specified product, include manufacturers cut sheets, dimensional data, performance data, installation instructions, wirings diagrams, power requirements, specified options, and warranty information.

1.5 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Include a copy of each approved submittal along with any applicable maintenance data in the project operation and maintenance manual.

1.7 QUALITY ASSURANCE

A. Materials and application of pipe hangers and supports shall conform to latest requirements of ANSI/ASME B31 Code for Pressure Piping and MSS Standard Practice SP-58 (Materials, design and Manufacture), SP-69 (Selection and Application), and SP-89 (Fabrication and Installation Practices), except as supplemented or modified herein.

B. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

C. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

1.8 WARRANTY/GUARANTEE

A. See Division 23 Specification Section “Basic Mechanical Requirements – HVAC” for warranty and guarantee requirements.

## PART 2 - PRODUCTS

### 2.1 GENERAL PRODUCT REQUIREMENTS

A. Design and Selection: Hangers and supports shall be designed and selected, for the intended use, in accordance with the requirements of this specification.

B. Acceptable Manufacturers: Subject to compliance with requirements, provide comparable product by one (1) of the following:

1. Metal Pipe Hangers and Supports:
   a. B-Line.
   b. Fee and Mason.
   c. Anvil.
   d. Michigan Hanger.

2. Thermal-Hanger Shield Inserts (Pre-Insulated Pipe Supports):
   a. Pipe Shields, Inc. (Piping technology & Products, Inc.)
   b. Bergen Pre-Insulated Pipe Supports
   c. Rilco.

3. Thermal-Hanger Shield Inserts:
   a. Pipe Shields, Inc. (Piping technology & Products, Inc.)
   b. Bergen Pre-Insulated Pipe Supports
   c. Rilco.

4. Fastener Systems (Concrete Anchors):
   a. Hilti,
   b. Powers Fasteners or
   c. Red Head

5. Metal Framing Support System:
   a. Unistrut,
   b. B-Line Strut Systems
   c. Anvil-Strut
   d. Kindorf
   e. Hilti

6. Pipe Guides and Anchors:
   a. Shaw Pipe Shields
   b. Bergen Pre-Insulated Pipe Supports
   c. Rilco

7. Pipe and Equipment Supports - Roof Level:
   a. Pate Company.

b. Roof Products and Systems (RPS).
c. Tybar Corporation.

2.2 METAL PIPE HANGERS AND SUPPORTS

A. Insulated Horizontal Piping Hangers: Chilled Water (fluid temperature at or below 100 ºF):

1. Two (2) inch and smaller: Figure No. B3108 with metal shield, Figure No. B3151.
2. Two and one-half (2-1/2) inch and larger: Figure No. B3108 with metal shield, Figure No. B3151.

B. Insulated and non-insulated vertical piping hangers:

1. Figure No B3373

C. Insulated and non-insulated vertical piping hangers:

1. Hangers Copper: B3373F.

2.3 TRAPEZE PIPE AND EQUIPMENT HANGERS

A. Description: Direct mounting hangers:

1. Anvil Figure No. 46.
2. Piping: Use straps, slides or rollers as specified below for Flat Surface (Trapeze, Rack Type) support system.
3. Suspended Equipment: Contractor shall support suspended equipment with any combination of trapeze supports, or miscellaneous steel angles or channels properly sized for the weight and hung from the structure with spring isolation hangers.

2.4 FLAT SURFACES (TRAPEZE, RACK TYPE)

A. Description: Use structural steel members such as struts, angles, channels and beams to support pipes as required. Select members properly for pipe support types and loading conditions. Submit support details with type of members selected and load calculations. Provide straps, clamps, rollers or slides indicated below at each support point.

B. Non - Insulated Horizontal Piping:

1. Six (6) inch and smaller (steel): Vibra-Clamp, B-Line, Figure No. BVT.
2. Eight (8) inch and larger (steel): U-Bolt, B-Line, Figure No. B3188.
3. All sizes (copper): Vibra-Clamp, B-Line, Figure No. BVT.

C. Insulated Horizontal Piping: Chilled Water (fluid temperature at or below 100 ºF):

1. Eight (8) inch and smaller: U-Bolt, B-Line, Figure No. B3188.
2. Ten (10) inch and larger: Roller, B-Line Figure No. B3120, B3122, B3122A, B3117SL.

2.5 INSULATION PROTECTION SHIELDS

A. B-Line Figure No. 3151 constructed of galvanized carbon steel. Per the latest edition of Standard MSS SP-58, select shield to accommodate outer diameter of insulation. Shield length and gauge for insulation compression strength not less than 15 psi.

B. Minimum 18 gauge thick and 12" long for piping up to 4", 16 gauge thick and 18" long for piping 5" through 6", 14 gauge thick and 24" long for piping 8" through 14" and 12 gauge thick and 24" long for piping 16" and larger.

C. Shields and saddles for fiberglass piping shall be provided as recommended by the piping system manufacturer.

2.6 INSULATION PROTECTION SADDLES

A. B-Line Figure No. 3160 through 3165 constructed of carbon steel or alloy steel plate. Select saddles to accommodate insulation thickness specified.

2.7 THERMAL-HANGER SHIELD INSERTS

A. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.

B. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.

C. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

E. Insert Length: Extend two (2) inches beyond sheet metal shield for piping operating below ambient air temperature.

2.8 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.9 PIPE STANDS

A. For support of pipe where axial movement is encountered: Figure No. B33117Sl where no vertical adjustments is required; and Figure B3118SL where vertical adjustments is required.

B. Compact Pipe Stand: One (1) piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe.

C. Low-Type, Single-Pipe Stand: One (1) piece stainless-steel base unit with plastic roller, for roof installation without membrane penetration.

D. High-Type, Single-Pipe Stand:

1. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
2. Base: Stainless steel.
3. Vertical Members: Two (2) or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.

E. High-Type, Multiple-Pipe Stand:

1. Description: Assembly of bases, vertical and horizontal members, and pipe supports.
2. Bases: One or more; plastic.
3. Vertical Members: Two (2) or more protective-coated-steel channels.
4. Horizontal Member: Protective-coated-steel channel.
5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.

2.10 PIPE POSITIONING SYSTEMS

A. Description: IAPMO PS 42, positioning system of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.

2.11 FABRICATED EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

B. Delegated Design: Calculate requirements for support of equipment weight and restraint of both lateral and vertical dynamic forces at 150% of operating conditions.

C. Details: Detail fabrication of each support assembly. Show dimensions and methods of assembly and attachment to building structure.

2.12 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5,000-psi, (34.5-MPa)(34.5-MPa)(34.5- MPa), twenty eight (28) day compressive strength.
3. Water: Potable
4. Packaging: Premixed and factory-packaged.

C. Washers: ASTM F 844, steel, plain, flat washers.

D. Vertical Piping Riser Clamps:

1. Copper Pipe: Figure No. B3373CT.
2. Steel Pipe: Figure No. B3136 and B3137.

E. Beam Clamps and Attachments:

1. For bolt-on locations to structure, Figure Nos. B3291, B3036, B3050.
2. Welded beam attachments, Figure No. B3083.

F. Concrete Inserts:

1. For concrete spot inserts at single locations for casting into structure, Figure No. B3014 for pre- determined rod size and Figure No. B2500 for universal use.
2. For continuous slot concrete insert at multi-locations for casting into structure, Figure No. B2505.

G. Brackets:

1. For equipment and piping adjacent to walls or steel columns, Figure Nos. B3066, B3063 and B3067 depending on weight to be supported.

H. Pipe Rests:

1. For pipes close to floor where no expansion provision is required, Figure No. B3088T base stand with B3093 adjustable pipe saddles support.

I. Hanger Rods:

1. Hanger rod, Figure No. B3205.
2. Continuous threaded rod, Figure No. ATR.
3. Eye rods, Figure No. B3210 or B3211, depending on load supported.

J. Spring Hangers:

1. Light loads, movement less than one and one quarter (1-1/4) inches, Figure No. B3262 or B3264.

K. Protection Saddles:

1. Cast iron pipe, insulated, Figure No. B3108 with metal shield, Figure No. B3151.

## PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

A. Install supports to allow for free expansion of piping. Support piping from building structural members using concrete inserts, beam clamps, ceiling plates, wall brackets, or floor stands. At no time shall hangers and supports overload building structural members. Fasten ceiling plates and wall brackets securely to structure and test to demonstrate adequacy of fastening.

B. Select and size building attachments properly in accordance with MSS Standards and manufacturer's published load rating information.

C. Coordinate hanger and support installation to properly group piping of all trades.

D. Suspend hangers by means of hanger rods. Perforated band iron and flat wire (strap iron) are not allowed.

E. Piping and ductwork shall be supported independently from other piping or ductwork.

F. Pipe hangers and supports shall not penetrate vapor barrier of pipe insulation.

G. Do not support equipment, piping or ductwork from metal roof decking or ceiling grid.

H. Install adequate supports so as not to over stress either piping or equipment to which piping is connected.

3.2 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly supported piping from the building structure.

1. Horizontal Piping: Support horizontal piping within twelve (12) inches of each fitting and coupling.
2. Base of Vertical Piping: Provide MSS Type 52, spring hangers.
3. Vertical Pipe Supports: Install supports for vertical steel pipe and copper tubing at each floor level.
4. Individual, Straight, Horizontal Piping Runs:

a. One hundred (100) Feet and Less: MSS Type 1, adjustable, steel, clevis hangers.
b. Longer than One Hundred (100) Feet: MSS Type 43, adjustable, roller hangers.
c. Longer than One hundred (100) Feet if Indicated: MSS Type 49, spring cushion rolls.
d. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
e. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
f. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
3. Multiple, Straight, Horizontal Piping Runs One hundred (100) Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.

C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.

D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

E. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than four (4) inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

F. Pipe Stand Installation:

1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.

G. Pipe Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.

H. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

I. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

J. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

K. Install lateral bracing with pipe hangers and supports to prevent swaying.

L. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

M. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

N. Upper attachments to structures shall have an allowable load not exceeding one quarter (1/4) of the failure (proof test) load but are not limited to the specific methods indicated.

O. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

P. Insulated Piping:

1. Attach clamps and spacers to piping.

   a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
   b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
   c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:

   a. NPS 1/4 to NPS 3-1/2: Twelve (12) inches long and 0.048 inch thick.
   b. NPS 4: Twelve (12) inches long and 0.06 inch thick.
   c. NPS 5 and NPS 6: Eighteen (18) inches long and 0.06 inch thick.
   d. NPS 8 to NPS 14: Twenty four (24) inches long and 0.075 inch thick.
   e. NPS 16 to NPS 24: Twenty four (24) inches long and 0.105 inch thick.

5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

Q. Conform to the table below for maximum spacing of supports and rod sizes:

1. Steel and Copper Pipe:

| Nom. Pipe Size - In. | Steel Pipe Max. Span - Ft. (In.) | Copper Tube Max. Span - Ft. (In.) | Min. Rod Dia. – In. |
|---|---|---|---|

| | | | |
|---|---|---|---|
| Up to 3/4 | 7 (84) | 5 (60) | 3/8 |
| 1 | 7 (84) | 6 (72) | 3/8 |
| 1-1/4 | 7 (84) | 7 (84) | 3/8 |
| 1-1/2 | 9 (108) | 8 (96) | 3/8 |
| 2 | 10 (120) | 8 (96) | 3/8 |
| 2-1/2 | 11 (132) | 9 (108) | 1/2 |
| 3 | 12 (144) | 10 (120) | 1/2 |
| 3-1/2 | 13 (156) | 11 (132) | 1/2 |
| 4 | 14 (168) | 12 (144) | 5/8 (1/2 for copper) |
| 5 | 16 (192) | 13 (156) | 5/8 (1/2 for copper) |
| 6 | 17 (204) | 14 (168) | 3/4 (5/8 for copper) |
| 8 | 19 (228) | 16 (192) | 7/8 (3/4 for copper) |
| 10 | 22 (264) | 18 (216) | 7/8 (3/4 for copper) |
| 12 | 23 (276) | 19 (228) | 7/8 (3/4 for copper) |

a. Support vertical steel pipe and copper tube at each floor level.
b. Rod diameter may be reduced one (1) size for double-rod hangers, with three eights (3/8) inch minimum rods.

## 3.3 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

## 3.4 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to one and one half (1-1/2) inches.

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Architectural Specification Sections "Exterior Painting" and/or Section "Interior Painting."

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 230529

# SECTION 230533 – HEAT TRACING FOR HVAC PIPING

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 23.

### 1.2 SUMMARY

A. This section includes the requirements for heat tracing HVAC piping for freeze prevention, with the following electric heating cables:

1. Self-regulating, parallel resistance.

### 1.3 ACTION SUBMITTALS

A. Product Data: For each product specified, include manufacturers cut sheets, dimensional data, performance data, installation instructions, wirings diagrams, power requirements, specified options, and warranty information.

B. Shop Drawings: For electric heating cable include:

1. Heat tracing system shop drawings shall include elevations, sections, and attachment details. Include diagrams for power, signal, and control wiring.
2. Scheduled information shall include heating capacity, length of cable, spacing, and electrical power requirement for each electric heating cable required.
3. Engineering data sheets for manufactured materials shall include dimensions, rated capacities, operating characteristics, and furnished specialties and accessories.

### 1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Sample Warranty: For special warranty.

### 1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Include a copy of the final approved submittal for each product in the operation and maintenance manuals.

### 1.6 WARRANTY/GUARANTEE

A. See Division 23 Specification Section “Basic Mechanical Requirements – HVAC” for warranty and guarantee requirements.

## PART 2 - PRODUCTS

### 2.1 GENERAL PRODUCT REQUIREMENTS

A. Equipment Design and Selection: Heat tracing equipment and specialties shall be designed and selected, for the intended use, in accordance with the scheduled capacities on the drawings and the requirements of this specification.

B. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. Heat Trace System and Accessories:

a. Brisk Heat.
b. Chromalox.
c. Delta-Therm Corporation.
d. Easy Heat; a division of EGS Electrical Group LLC.
e. Nelson Heat Trace; a division of EGS Electrical Group LLC.
f. Pyrotenax; a brand of Tyco Thermal Controls LLC.
g. Raychem; a brand of Tyco Thermal Controls LLC.
h. Thermon Americas Inc.

### 2.2 SELF-REGULATING, PARALLEL-RESISTANCE HEATING CABLES

A. Comply with IEEE 515.1.

B. Heating Element: Pair of parallel No. 16 AWG, tinned, stranded copper bus wires embedded in crosslinked conductive polymer core, which varies heat output in response to temperature along its length. Terminate with waterproof, factory-assembled, nonheating leads with connectors at one end, and seal the opposite end watertight. Cable shall be capable of crossing over itself once without overheating.

C. Electrical Insulating Jacket: Flame-retardant polyolefin.

D. Outer jacket in "Cable Cover" Paragraph below is optional feature and is required for waterproof applications; verify availability with manufacturer.

E. Cable Cover: Tinned-copper braid and polyolefin outer jacket with ultraviolet inhibitor.

F. Maximum Operating Temperature (Power On): 150°F.

G. Verify temperature of circulated media in freeze-protected piping in "Maximum Exposure Temperature (Power Off)" Paragraph below.

H. Maximum Exposure Temperature (Power Off): 185°F.

I. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

J. Capacities and Characteristics:

1. Maximum Heat Output: Five (5) Watts/ft.
2. Electrical Characteristics for Single-Circuit Connection:

a. Volts: One hundred twenty (120)
b. Phase: Single (1) phase
c. Hertz: Sixty (60)

2.3 CONTROLS

A. Pipe-Mounted Thermostats for Freeze Protection:

1. Remote bulb unit with adjustable temperature range from 30°F to 50°F.
2. Snap action; open-on-rise, single-pole switch with minimum current rating adequate for connected cable.
3. Remote bulb on capillary, resistance temperature device, or thermistor for directly sensing pipe-wall temperature.
4. Corrosion-resistant, waterproof control enclosure.

B. Precipitation and Temperature Sensor for Snow Melting on Roofs and in Gutters:

1. Microprocessor-based control with manual on, automatic, and standby/reset switch.
2. Precipitation and temperature sensors shall sense the surface conditions of roof and gutters and shall be programmed to energize the cable as follows:

a. Temperature Span: 34°F to 44°F.
b. Adjustable Delay-Off Span: Zero (0) to ninety (90) minutes.
c. Energize Cables: Following two (2) minute delay if ambient temperature is below set point and precipitation is detected.
d. De-Energize Cables: On detection of a dry surface plus time delay.

3. Corrosion-proof and waterproof enclosure suitable for outdoor mounting, for controls and precipitation and temperature sensors.
4. Minimum Thirty (30)-A contactor to energize cable or close other contactors.
5. Freestanding sensor can be used for snow and ice melting on roofs and in gutters.
6. Precipitation sensor shall be freestanding.
7. Provide relay with contacts to indicate operational status, on or off, for interface with central HVAC control-system workstation.

2.4 ACCESSORIES

A. Cable Installation Accessories: Fiberglass tape, heat-conductive putty, cable ties, silicone end seals and splice kits, and installation clips all furnished by manufacturer, or as recommended in writing by manufacturer.

B. Warning Labels: Refer to Division 23 Specification Section "Identification for HVAC Systems and Equipment."

C. Warning Tape: Continuously printed "Electrical Tracing"; vinyl, at least 3 mils thick, and with pressure-sensitive, permanent, waterproof, self-adhesive back.

1. Width for Markers on Pipes with OD, Including Insulation, Less Than six (6) Inches: Three quarter (3/4) inch minimum.
2. Width for Markers on Pipes with OD, Including Insulation, six (6) Inches or Larger: One and one half (1-1/2) inches minimum.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine surfaces and substrates to receive electric heating cables for compliance with requirements for installation tolerances and other conditions affecting performance.

1. Ensure surfaces and pipes in contact with electric heating cables are free of burrs and sharp protrusions.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Install the following types of electric heating cable for the applications described:

1. Self-regulating, parallel-resistance heating cable.

3.3 INSTALLATION

A. Install electric heating cable across expansion, construction, and control joints according to manufacturer's written instructions; use cable-protection conduit and slack cable to allow movement without damage to cable.

B. Electric Heating-Cable Installation for Freeze Protection for Piping:

1. Install electric heating cables after piping has been tested and before insulation is installed.
2. Install electric heating cables according to IEEE 515.1.

3. Install insulation over piping with electric cables according to Division 23 Specification Section "Insulation for HVAC Pipe and Duct Systems."
4. Install warning tape on piping insulation where piping is equipped with electric heating cables.

C. Set field-adjustable switches and circuit-breaker trip ranges.

3.4 CONNECTIONS

A. Ground equipment according to Division 26 Specification Section "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Division 26 Specification Section "Low-Voltage Electrical Power Conductors and Cables."

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Perform tests after cable installation but before application of coverings such as insulation, wall or ceiling construction, or concrete.
2. Test cables for electrical continuity and insulation integrity before energizing.
3. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.

D. Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation on pipe-mounted cables.

E. Cables will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

3.6 PROTECTION

A. Protect installed heating cables, including nonheating leads, from damage during construction.

B. Remove and replace damaged heat-tracing cables.

END OF SECTION 230533

# SECTION 230553 – IDENTIFICATION FOR HVAC SYSTEMS AND EQUIPMENT

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 23.

### 1.2 SUMMARY

A. This section includes the requirements for identification of HVAC piping and equipment using the following:

1. Equipment labels.
2. Warning signs.
3. HVAC pipe system labels.
4. HVAC duct system stencils.
5. Valve tags.
6. Ceiling markers.
7. Engraved signs.
8. Warning tags
9. Underground pipe markers.

### 1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Samples: For color, letter style, and graphic representation required for each identification material and device.
2. Data: Installation details, material descriptions, dimensions of individual components for each type tag and sign.
3. Equipment Label Schedule: Submit a sample equipment label schedule for each fire protection system. Include a list of all equipment to be labeled, the proposed content for each label and the location in an “xl” file format.
4. Valve Numbering Schedule: Submit a sample valve tag schedule for each fire protection system. Include equipment tag designation, name and location in an “xl” file format.

### 1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Include a copy of the final approved submittal for each product in the operation and maintenance manuals.

B. Valve Schedules: Include a valve schedule for each piping system in the operation and maintenance manual. The valve schedule shall be an electronic file in “doc” format and

printed as a "pdf" file for insertion in the O & M manual. Submit the "doc" file separate from the O & M electronic file.

1.5 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

D. Names, Abbreviations and Designations: Coordinate names, abbreviations and other designations used in mechanical identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of mechanical systems and equipment.

1.6 WARRANTY/GUARANTEE

A. See Division 23, Specification Section "Basic Mechanical Requirements – HVAC" for warranty and guarantee requirements.

**PART 2 - PRODUCTS**

2.1 GENERAL PRODUCT REQUIREMENTS

A. Labels, Signs and Tags: All labels, signs and tags shall conform to ANSI/OSHA requirements for letter/color combinations.

B. Basis of Design: The basis of design shall be mechanical identifications materials manufactured by the Seton Name Plate Corporation as follows:

1. Equipment Labels – Style M4562 – M4565
2. Warning Signs – Style M4562 – M4565
3. HVAC Pipe Labels – Size 8SM - 32
4. Duct System Labels – Custom Stencils
5. Valve Tags – Style 374

C. Other Acceptable Manufacturers: Subject to compliance with requirements, provide mechanical identifications materials from one (1) of the following:

1. Brady (Wilt.) Co. Singmark Division.
2. Industrial Safety Supply Co., Inc.

2.2 EQUIPMENT LABELS

A. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, one eighth (1/8) inch thick, and having predrilled holes for attachment hardware.
2. Minimum Label Size: Length and width vary for required label content, but not less than two and one half (2-1/2) inch by three quarter (3/4) inch.
3. Minimum Letter Size: One quarter (1/4) inch for name of units if viewing distance is less than twenty four (24) inches, one half (1/2) inch for viewing distances up to seventy two (72) inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two thirds (2/3) to three fourths (3/4) the size of principal lettering.
4. Fasteners: Self tapping stainless steel screws, screws, except contact type permanent adhesive where screws cannot or should not penetrate the substrate.
5. Adhesive: Contact type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's label as indicated on the construction documents.

C. Equipment Label Schedule:

2.3 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, one eighth (1/8) inch thick, and having predrilled holes for attachment hardware.

B. Minimum Label Size: Length and width vary for required label content, but not less than two and one half (2-1/2) inch by three quarter (3/4) inch.

C. Minimum Letter Size: One quarter (1/4) inch for name of units if viewing distance is less than twenty four (24) inches, one half (1/2) inch for viewing distances up to seventy two (72) inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two thirds (2/3) to three quarters (3/4) the size of principal lettering.

D. Fasteners: Stainless steel self tapping screws.

E. Adhesive: Contact type permanent adhesive, compatible with label and with substrate.

F. Label Content: Include caution and warning information plus emergency notification instructions.

2.4 HVAC PIPE SYSTEMS LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color coded, with lettering indicating service, and showing flow direction according to ASME A13.1.

1. Do not use pipe labels or plastic tapes for bare pipes conveying fluids at temperatures of 125°F (52°C) or higher

B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover or cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

1. Small Pipes: For external diameters less than six (6) inches (including insulation if any, provide full band pipe markers, extending 360 degrees around pipe at each location, fastened by one (1) of the following methods:

a. Snap-on application of pre-tensioned semi-rigid plastic pipe marker.
b. Adhesive lap joint in pipe marker overlap.
c. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than three quarter (3/4) inch wide; full circle at both ends of pipe marker, tape lapped one and one half (1-1/2) inches.

2. Large Pipes: For external diameters of six (6) inches and larger (including insulation if any), provide either full band or strip type pipe markers, but not narrower than three (3) times letter height (and of required length), strapped to pipe (or insulation) application of semi rigid type, with manufacturer's standard nylon ties.

a. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than one and one half (1-1/2) inches wide; full circle at both ends of pipe marker, tape lapped three (3) inches.
b. Strapped-to-pipe (or insulation) application of semi-rigid type, with manufacturer's standard stainless steel bands.

C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

D. Pipe Label Contents: Pipe label contents shall comply with the following:

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: At least one and one half (1-1/2) inches high.
3. Label Designation and Colors: See chart on the next page.

| HVAC SERVICE DESIGNATION | LABEL DISIGNATION | FIELD/LETTER COLOR |
|---|---|---|
| Primary Chilled Water Supply | Same as Service Designation | Yellow / Black |
| Primary Chilled Water Return | Same as Service Designation | Yellow / Black |
| Process Cooling Water Supply | Same as Service Designation | Yellow / Black |
| Process Cooling Water Return | Same as Service Designation | Yellow / Black |

| | | |
|---|---|---|
| AC Condensate Drain | Same as Service Designation | Yellow / Black |
| | | |
| | | |
| | | |
| | | |

2.5 HVAC DUCT SYSTEM STENCILS

A. Custom Stencils for Duct Systems:

1. Stencil Material: Brown Oil Board
2. Lettering Size: Minimum letter height of three (3) inches. Stencil designations can be one (1) or two (2) lines.
3. Number of Characters: The number of characters may be up to fifty (50) depending on the specified designation.
4. Stencil Paint: Exterior, gloss, black acrylic enamel. Paint may be in pressurized spray can form.
5. Directional Arrows: Include directional arrows.

B. Stencils for Access Panels and Door Labels

1. Lettering Size: Minimum letter height of one half (1/2) inch for viewing distances up to seventy two (72) inches and proportionately larger lettering for greater viewing distances.
2. Stencil Paint: Exterior, gloss, acrylic enamel. Paint may be in pressurized spray can form.
3. Identification Paint: Exterior, acrylic enamel. Paint may be in pressurized spray can form.

C. Duct Stencil Markers: Provide duct stencil markers with the following designations and letter color:

| SERVICE | STENCIL DISIGNATION | LETTER COLOR |
|---|---|---|
| Main Supply Air Duct | Main Supply Air Duct – AHU – # | Black |
| General Exhaust Air Duct | General Exhaust Air Duct – GEF – # | Black |
| Supply Air Duct | Supply Air Duct – STU – # | Black |
| Exhaust Air Duct | Exhaust Air Duct – ETU – # | Black |
| Outside Air | Out Side Air – AHU – # | Black |
| Relief Air | Relief Air – AHU – # | Black |
| Access Door - Supply | ADS – Positive Pressure | Black |
| Access Door - Exhaust | ADE – Negative Pressure | Black |

## 2.6 VALVE TAGS AND SCHEDULE

A. General: Valve tags and schedule are required to identify what systems the valves are installed in, where the valves are located and what duty the valves perform. Valve duty usually includes the following:

1. Shut off duty for rooms, equipment, control valves and/or floors.
2. Combination balancing/shut off duty.
3. Riser isolation duty.
4. Drain valves.
5. Control valves.
6. Shut off duty for back flow preventer.

B. Valve Tags:

1. Description: Stamped or engraved with one quarter (1/4) inch letters for piping system abbreviation and one half (1/2) inch numbers

   a. Brass Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
   b. Fasteners: Brass wire-link chain

2. Plastic Laminate Valve Tags: Provide manufacturer's standard three thirty second (3/32) inch thick engraved plastic laminate valve tags, with piping system abbreviation in one quarter (1/4) inch high letters and sequenced valve numbers one half (1/2) inch high, and with five thirty second (5/32) inch hole for fastener.

   a. Provide One and one half (1-1/2) inch sq. black tags with white lettering, except as otherwise indicated.
   b. Provide size, shape and color combination as specified or scheduled for each piping system.

3. Plastic Valve Tags: Provide manufacturer's standard solid plastic valve tags with printed enamel lettering, with piping system abbreviation in approximately three sixteenth (3/16) inch high letters and sequenced valve numbers approximately three eights (3/8) inches high, and with five thirty second (5/32) inch hole for fastener.

   a. Provide one and one eighth (1-1/8) inch sq. white tags with black lettering.
   b. Provide size, shape and color combination as specified or scheduled for each piping system.
   c. Valve Tag Fasteners: Provide manufacturer's standard solid brass chain (wire link or beaded type), or solid brass S-hooks of the sizes required for

proper attachment of tags to valves, and manufactured specifically for that purpose.

4. Valve Tag Data: See chart below:

| HVAC VALVE SERVICE | VALVE TAG DISIGNATION |
|---|---|
| Chilled Water Supply | CHS – # |
| Chilled Water Return | CHR-# |
| Process Chilled Water Supply | PWS-# |
| Process Chilled Water Return | PWR-# |

C. Valve Schedules: Provide a valve schedule in an "xl" file format for each HVAC piping system. File shall include the valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room, space, equipment, pipe riser), and valve duty. Also mark valves for emergency shutoff and similar special uses as required by the project.

1. Numbering System: Valves shall be in numerical order starting with one (1) for each HVAC system.

2. BAS Control Valves: BAS control valves shall be numbered in numerical order for each HVAC system utilizing the "control valve number from the BAS submittal.

2.7 CEILING MARKERS

A. Ceiling Grid and Access Panel Markers: Provide Kroy type clear adhesive printed labels with three sixteenth (3/16) inch high letters to identify the type of concealed equipment, valves, volume dampers, reheat coils, control dampers, etc.

B. Ceiling Marker Data: For HVAC the printed data shall be as follows:

| ITEM | SERVICE | LABEL |
|---|---|---|
| LP Drain | Low Point Drain | HVAC – LPD – ** |
| Air Vent | Manual Air Vent | HVAC – MAV |
| STU | Supply Terminal Unit | HVAC – STU |
| GETU | General Exhaust Terminal Unit | HVAC – GETU |
| DFDAD | Duct Fire Damper Access Door | HVAC – DFDAD |
| DFSDAD | Duct Fire/Smoke Damper Access Door | HVAC – DFSDAD |

** System ID: Chilled Water (CHW)

2.8 ENGRAVED PLASTIC LAMINATE SIGNS

A. General: Provide engraving stock melamine plastic laminate, complying with FS L-P-387, in the sizes and thicknesses indicated, engraved with engraver's standard letter style of the sizes and wording indicated, black with white core (letter color) except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.

B. Thickness: One eighth (1/8) inch, except as otherwise indicated.

C. Fasteners: Self tapping stainless steel screws, except contact type permanent adhesive where screws cannot or should not penetrate the substrate.

D. Nomenclature: Include the following, matching terminology on schedules as closely as possible.

E. Size: Provide approximate two and one half (2-1/2) inch x four (4) inch markers for control devices, dampers, and valves; and four and one half (4-1/2) inch x six (6) inches for equipment.

2.9 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.

1. Size: Three (3) inches by five and one quarter (5-1/4) inches minimum.
2. Fasteners: Self tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.
3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
4. Color: Yellow background with black lettering.

**PART 3 - EXECUTION**

3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

3.3 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.4 PIPE LABEL INSTALLATION

A. Piping Color Coding: Per schedule.

B. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations and on both sides of through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of fifty (50) feet along each run. Reduce intervals to twenty five (25) feet in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

C. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

3.5 DUCT LABEL INSTALLATION

A. Stenciled Duct Label Option: Stenciled labels showing service and flow direction may be provided instead of plastic-laminated duct labels, at Installer's option.

B. Locate labels near points where ducts enter into and exit from concealed spaces and at maximum intervals of fifty (50) feet in each space where ducts are exposed or concealed by removable ceiling system.

3.6 VALVE TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves, valves within factory fabricated equipment units, shutoff valves, faucets, convenience

connections, and HVAC terminal devices and similar roughing in connections of end use fixtures and units. List tagged valves in a valve schedule.

3.7 WARNING TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

3.8 VALVE TAG SCHEDULE

A. Include the valve schedule file in the electronic operation and maintenance manual.

3.9 CEILING MARKERS

A. Location: Install each ceiling marker label on the surface of the ceiling grid 'T' bar and/or on the frame of an access door.

3.10 ADJUSTING AND CLEANING

A. Adjusting: Relocate any mechanical identification device which has become visually blocked by work of this division or other divisions.

B. Cleaning: Clean face of identification devices.

END OF SECTION 230553

# SECTION 230593 – TESTING, ADJUSTING, AND BALANCING HVAC SYSTEMS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 23.

### 1.2 SUMMARY

A. This section includes the requirements for testing, adjusting and balancing the following systems:

1. Balancing Air Systems:

   a. Supply air distribution systems.
   b. Exhaust air distribution systems.
   c. Supply and exhaust air devices.

2. Balancing Hydronic Piping Systems:

   a. Secondary hydronic systems.

3. Testing, Adjusting, and Balancing Equipment:

   a. Air handling units.
   b. Heat transfer coils.
   c. Fan coil units, cabinet heaters, unit heaters.
   d. Exhaust/Relief/Return air fans.

### 1.3 PREINSTALLATION MEETINGS <Coordinate with UMB. Delete if not required for Project>

A. TAB Conference: Conduct a TAB conference at Project site after approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Provide a minimum of fourteen (14) days' advance notice of scheduled meeting time and location.

1. Minimum Agenda Items:

   a. The Contract Documents examination report.
   b. The TAB plan.
   c. Needs for coordination and cooperation of trades and subcontractors.
   d. Proposed procedures for documentation and communication flow

1.4 ACTION SUBMITTALS

A. Agency Data: within thirty (30) days of award of contract submit proof that proposed testing, adjusting, and balancing agency meets the qualifications specified.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: Within thirty (30) days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Contract Documents Examination Report: Within ninety (90) days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.

C. Strategies and Procedures Plan: Within sixty (60) days of Contractor's Notice to Proceed, submit TAB strategies and step by step procedures as specified in "Preparation" Article.

D. System Readiness Checklists: Within ninety (90) days of Contractor's Notice to Proceed, submit system readiness checklists as specified in "Preparation" Article.

E. Examination Report: Submit a summary report of the examination review required in "Examination" Article.

F. Final TAB Report Submittal: Within thirty (30) days after all fieldwork has been completed, submit a final TAB report as detailed in Part 3 of this Section to assure design objectives are met and to assist Owner in future maintenance.

1.6 CLOSEOUT SUBMITTAL

A. Operation and Maintenance Data: Include a copy of the final approved TAB Report in the operation and maintenance manuals.

1.7 QUALITY ASSURANCE

A. General: Employ services of an independent testing, adjusting, and balancing agency to be the single source of responsibility to test, adjust, and balance the HVAC systems indicated on the drawings serving the project area. Services shall include checking installations for conformity to design, measurement and establishment of fluid quantities of mechanical systems as required to meet the requirements of the design documents, and record and report the results.

B. Certification: Certified by Associated Air Balance Council (AABC) in those testing and balancing disciplines required for this project, and having at least one (1) Professional Engineer registered in State in which services are to be performed, certified by AABC as Test and Balance Engineer. NEBB certified balancing companies will not be permitted.

C. TAB Specialists Qualifications: Certified by AABC.

1. TAB Field Supervisor: Employee of the TAB specialist and certified by AABC.
2. TAB Technician: Employee of the TAB specialist and certified by AABC as a TAB technician.

D. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."

E. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

F. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

G. Work shall be accomplished in accordance with specifications. Procedures specified shall be followed and, if not specifically described herein, in general, shall be in accordance with Associated Air Balance Council's National Standards.

H. Design Review: Review all design drawings and specifications.

1. Review shall include:

a. Duct pressure classification.
b. Control device location and balancing devices location in duct systems and piping systems.
c. Indicate additional balancing devices required for proper balancing.
d. Specifications on all devices required for balancing.
e. Note any potential noise problems.

2. Within ninety (90) days of award of contract, meet with the CM, Owner, A/E, Mechanical Contractor, and Building Automation System Contractor to review procedures and agenda and comments on design documents as to potential problem areas.

I. Shop Drawing Review: Review the Building Automation System (BAS) shop drawing submittals noting any potential balancing problems. Note comments on submittal, sign, stamp and return to General Contractor. All BAS submittals must be reviewed by balancing agency prior to review by the engineer.

J. Pre Balancing Conference: Prior to beginning of testing, adjusting, and balancing procedures, schedule and conduct conference with the CM, Owner, and representatives of installers of mechanical systems. Objective of conference is final coordination and verification of system operation and readiness for testing, adjusting, and balancing.

K. During construction, balancing agency shall inspect the installation of pipe systems, sheet metal work, temperature controls, and other component parts of heating, ventilating, and

air conditioning systems. Inspections shall be performed periodically as work progresses. Minimum of two (2) inspections are required as follows:

1. One (1) when 60% of ductwork is installed;
2. Two (2) when 90% of equipment is installed.
3. Balancing agency shall submit brief written report of each inspection to Owner and engineer.

1.8 STANDARDS

A. Associated Air Balance Council (AABC) Publication: National Standards for Testing and Balancing Heating, Ventilating and Air Conditioning Systems, Latest Edition.

B. American Society of Heating, Refrigeration and air Conditioning Engineers (ASHRAE) Publications:

1. "ASHRAE Research Report No. 1162, "Air Flow Measurements at Intake and Discharge Openings and Grilles," ASHVE Transactions, Volume 46.
2. ASHRAE Handbook of Fundamentals, Latest Edition.

C. American National Standards Institute (ANSI) Publications:

1. ANSI/AIHA Z9.5 American National Standard for Laboratory Ventilation, Latest Edition.
2. S1.4 General - Purpose Sound Level Meters, Specifications for,

D. Sheet Metal and Air Conditioning Contractors National Association Inc. (SMACNA) - Air Duct Leakage Test Manual, Latest Edition.

1.9 FIELD CONDITIONS

A. New Construction Project: University personnel will occupy the new building beginning from the projects date of substantial completion. All TAB operations shall be completed prior to the date of substantial completion.

1.10 WARRANTY/GUARANTEE

A. See Division 23 Specification Section “Basic Mechanical Requirements – HVAC” for warranty and guarantee requirements.

**PART 2 - PRODUCTS**

2.1 INSTRUMENTATION

A. Provide all required instrumentation to obtain proper measurements. Application of instruments and accuracy of instruments and measurements shall be in accordance with requirements of AABC.

B. Instruments used for measurements shall be accurate, and calibration histories for each instrument to be available for examination by A/E upon request. Calibration and maintenance of instruments shall be in accordance with requirements of AABC.

2.2 INSTRUMENT TEST HOLE PLUGS

A. Center-pull plugs similar to Alliance Plastics CP Series. Plug material shall be Grade 1 virgin polyethylene.

B. Do not drill test holes in welded ducts serving containment areas.

**PART 3 - EXECUTION**

3.1 GENERAL PROCEDURES

A. General: Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance" and in this Section to obtain air and water quantities indicated and required for proper operation of the systems.

B. System Operation: During all tests, it shall be demonstrated that all systems shall be free from leaks and all parts of each system are operating correctly. If not, report deficiencies to the CM/GC and the UMB – PM. Balancing Firm shall make final adjustments to equipment as may be required for proper operation, maintaining correct temperatures in all parts of the building. Controls shall be adjusted by BAS technicians in conjunction with Balancing Firm. Coordinate set points and adjustments with BAS.

C. Hydronic Systems: Balance each hydronic circulation system installed under this contract to achieve water quantities, pressure and temperature drops in all equipment and parts of system as indicated on the plans, in specifications, and on the approved shop drawings.

D. Air Systems: Balance each air circulation system, installed under this contract to achieve air quantities, pressure and temperature drops and static pressures in all equipment and parts of system as indicated on the plans, in specifications, and on the approved shop drawings.

E. Noise: Study and report on excessive noise conditions which may develop during system balancing. Report shall be sent to CM and UMB – PM in a form of a “pdf” file.

F. TAB Field Markings: Field mark equipment and balancing devices, including damper control positions, valve position indicators, fan speed control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

G. Traverse Test Probes: Where insulation on ductwork and/or plenums needs to be removed to perform traverse measurements cut and remove insulation as necessary to complete the TAB work. When the work has been completed plug each opening with a properly sized rubber grommet to seal the holes air tight. Coordinate with the mechanical contractor to have the duct insulation repaired to match its previous condition.

H. Acceptable System Tolerance: Unless otherwise specified, the maximum acceptable tolerances for the air and water flow rates shall be +/- 10% of the flow rates as indicated on the drawings and approved submittals.

## 3.2 TAB REPORT

A. TAB Report: The TAB report shall include the following:

1. Certification form signed and dated by a TAB professional engineer who represents the TAB Company.
2. Table of contents with separate sections for air system balance and hydronic system balance.
3. List of abbreviations used in the report.
4. List of instruments used with instrument type, manufacturer, serial number, range, and calibration date.
5. Job notes.
6. Completed TAB Data Forms as specified.

B. Units of Measurement: Units of measurements shall be in inch/pound (IP) units.

C. Equipment Labels: Includes all major equipment and devices in each system. Include the following:

1. Equipment tag from the drawings.
2. Equipment name.
3. Manufacturer.
4. Model number.
5. Serial number.
6. Location.

D. TAB Data Forms: For each component that requires a TAB procedure provide a TAB data form with the design data from the construction documents and/or approved submittals and the actual measured data that represents the operation of each system and components as follows:

1. Hydronic Systems and Equipment: AHU coils:

a. Total water flow rate in GPM.
b. Water side pressure drop in feet (ft.).
c. Water temperature entering in °F.
d. Water temperature leaving in °F.
e. Water side temperature difference in °F between EWT/LWT.

2. Air Systems and Equipment: Air handling units, and fans:

   a. Total air volume in CFM.
   b. Return air volume in CFM.
   c. Outside air volume in CFM.
   d. Static pressure (TSP/ESP) in inches wg.
   e. Suction pressure in inches wg.
   f. Discharge pressure in inches wg.
   g. Air side pressure drop in inches water gauge (wg).
   h. Air temperature entering in °F.
   i. Air temperature leaving in °F.
   j. Air side temperature difference in °F between EAT/LAT.
   k. Damper positions % open/closed.

3. Motors: For fans:

   a. Motor HP.
   b. Motor BHP.
   c. Motor volts and phase.
   d. Motor amps.
   e. Motor RPM.
   f. Fan RPM.
   g. Fan sheave.
   h. Motor sheave.
   i. Belts.
   j. Motor efficiency.

4. Air Devices: Diffusers and grilles:

   a. Outlet number.
   b. Outlet size
   c. Outlet type.
   d. Min/max air volume in CFM.

5. Terminal Units: Include cabinet heaters, unit heaters:

   a. Outlet number.
   b. Min/max air volume in CFM.
   c. Velocity pressure at minimum.
   d. Velocity pressure at maximum.
   e. DDC set point value.
   f. Damper position % open/closed.

6. Duct Traverses:

a. Duct height in inches.
b. Duct width in inches.
c. Duct area in square feet.
d. Average velocity in FPM.
e. Design air volume in CFM.
f. Actual air volume in CFM.
g. Duct S.P. in inches wg.
h. Measured velocity table with appropriate traverse points and velocity readings for indicated duct size.

E. Instrument Calibration Reports: Instrument calibration reports shall include the following data:

1. Instrument type and make.
2. Serial number.
3. Application.
4. Dates of use.
5. Dates of calibration.

3.3 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.

B. Examine installed systems for balancing devices, such as test ports, gage cocks, thermometer wells, flow control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.

C. Examine the approved submittals for HVAC systems and equipment.

D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine ceiling plenums used for supply, return, or relief air to verify that they are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire stopped if required.

F. Examine equipment performance data including fan curves.

1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

2. Calculate system effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

G. Examine system and equipment installations and verify that field quality control testing, cleaning, and adjusting specified in individual Sections have been performed.

H. Examine test reports specified in individual system and equipment Sections.

I. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.

J. Examine terminal units such as unit heaters, cabinet heaters, compressorized cooling units and verify that they are accessible and their controls are connected and functioning.

K. Examine strainers. Verify that startup screens have been replaced by permanent screens with indicated perforations.

L. Examine control valves for proper installation for their intended function of throttling, diverting, or mixing fluid flows.

M. Examine heat transfer coils for correct piping connections and for clean and straight fins.

N. Examine system pumps to ensure absence of entrained air in the suction piping.

O. Examine operating safety interlocks and controls on HVAC equipment.

P. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.4 PREPARATION

A. Perform system readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:

1. Air Side:

a. Verify that leakage and pressure tests on air distribution systems have been satisfactorily completed.

b. Duct systems are complete with terminals installed.
c. Volume, smoke, and fire dampers are open and functional.
d. Clean filters are installed.
e. Fans are operating, free of vibration, and rotating in correct direction.
f. Variable frequency controllers' startup is complete and safeties are verified.
g. Automatic temperature control systems are operational.
h. Ceilings are installed.
i. Windows and doors are installed.
j. Suitable access to balancing devices and equipment is provided.

2. Water Side:

a. Verify leakage and pressure tests on water distribution systems have been satisfactorily completed.
b. Piping is complete with terminals installed.
c. Water treatment is complete.
d. Systems are flushed, filled, and air purged.
e. Strainers are pulled and cleaned.
f. Control valves are functioning per the sequence of operation.
g. Shutoff and balance valves have been verified to be 100% open.
h. Pumps are started and proper rotation is verified.
i. Pump gage connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.
j. Variable frequency controllers' startup is complete and safeties are verified.
k. Suitable access to balancing devices and equipment is provided.

## 3.5 PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain approved submittals and manufacturer's outlet factors and recommended testing procedures. Cross check the summation of required outlet volumes with required fan design flow rates.

B. In conjunction with the BAS, fans and equipment shall be started and operated per design/approved sequence of operation.

C. With the supply and exhaust fans set for the respective design air flow volumes, system static pressures, fan rpm, motor rpm and power, and with system dampers set to handle normal minimum outdoor air perform and record the following test:

1. Air Handling Equipment:

a. Test for Total Air

1) Sum of discharge, exhaust air, return air and outside air ducts.

2) Number and locations of velocity readings taken.
3) Duct average velocity.
4) Total airflow.

b. After completion of tests, adjustments, and balancing under minimum outdoor air conditions, set system for 100% outdoor air. Repeat the total airflow tests to check field versus design conditions. Result's under the outdoor air cycle shall agree with conditions found under "minimum fresh air operation" before system is considered to be in balance. Adjustments of proper dampers shall be made to achieve balance.

c. If airflow is not within 10% of design capacity at rated speed, review system conditions, procedures, and recorded data. Check and record pressure drops across filters, compensate for clean versus dirty filters, coils, sound traps, airflow sensors, etc., to indicate excessive pressure loss or leakage. Resolve problems with appropriate contractor. If systems are properly operating, and airflow is still unacceptable, adjust fan drive in accordance with manufacturer's recommendations to obtain proper airflow and static pressure. Systems shall be balanced and operated at lowest feasible static pressure with allowance for filter loading. Record fan suction pressure, fan discharge pressure, amperage and airflow measurement. Correct fan curves to indicate new points of balance. Fan motor shall not be overloaded.

2. Air Duct Mains and Branches:

a. Design and actual airflow.
b. Adjust, measure and record airflow, static pressure of duct mains and branch ducts to provide required pressure and airflow at terminal devices.

3. Air Outlets (supply, return and exhaust registers diffusers and grilles):

a. Design and actual airflow.
b. Adjust outlets to obtain design airflow within ±5%.
c. Adjust direction of throw as required to match final installation location to prevent drafts.
d. With supply, return and exhaust balanced to design airflow, report room pressurization, (positive or negative). Record pressure readings relative to adjacent spaces and submit them to the Owner and Architect.

D. Sheaves and Belts: Should the air balance fall short of or exceed the specified tolerances, change and replace sheaves and belts to achieve the acceptable air balance. Replacement of sheaves and belts shall be provided at no additional cost.

E. Verify that air duct system is sealed as specified. Balancing contractor shall witness leakage tests required of sheet metal construction.

F. Balancing contractor shall witness leakage tests required of sheet metal contractor.

3.6 PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports for each system piece of equipment. Obtain approved submittals and manufacturer recommended testing procedures. Cross check the summation of required coil and equipment flow rates.

B. In conjunction with the BAS and equipment shall be started and operated per design/approved sequence of operation.

C. With manual valves open, and control valves in normal position, adjust discharge balancing valve to obtain design flow. Compare data with pump submittal curve. If test point falls on curve, proceed with balancing. If recorded data does not fall on pump curve, plot new curve parallel with other curves on chart, from zero to maximum flow. Open discharge balancing valve to full and record discharge pressure, suction pressure and total head. Readjust balancing valve to obtain suction and discharge design flow and pressure, and record data. Check and record pump motor voltage and amperage. Pump motor shall not be overloaded.

D. Check and Verify: Check and verify the following system requirements have been completed and are in proper working order:

1. Check liquid level in expansion tank.
2. Check highest vent for adequate pressure.
3. Check flow control valves for proper position.
4. Locate start/stop and disconnect switches, electrical interlocks, and motor starters.
5. Verify that motor starters are equipped with properly sized thermal protection.
6. Check that air has been purged from the system.

3.7 PROCEDURES FOR PRIMARY/ SECONDARY HYDRONIC SYSTEMS

A. Balance the primary circuit flow first.

B. Balance the secondary circuits after the primary circuits are complete.

1. Measure total water flow:

a. Position valves for full flow through coils.
b. Measure flow by main flow meter, if installed.
c. If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.

C. For systems with pressure independent valves at terminals:

1. Measure differential pressure and verify that it is within manufacturer's specified range.
2. Perform temperature tests after flows have been verified.

D. For systems without pressure independent valves or flow measuring devices at terminals:

1. Measure and balance coils by either coil pressure drop or temperature method.
2. If balanced by coil pressure drop, perform temperature tests after flows have been verified.

E. Verify final system conditions as follows:

1. Remeasure and confirm that total water flow is within design.
2. Mark final settings.
3. Verify that memory stops have been set.

## 3.8 PROCEDURES FOR MOTORS

A. Motors 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer's name, model number, and serial number.
2. Motor horsepower rating.
3. Motor rpm.
4. Phase and hertz.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter size and thermal protection element rating.
8. Service factor and frame size.

B. Motors Driven by Variable Frequency Controllers: Test manual bypass of controller to prove proper operation.

## 3.9 PROCEDURES FOR PRIMARY/ SECONDARY HYDRONIC SYSTEMS

A. Balance the primary circuit flow first.

B. Balance the secondary circuits after the primary circuits are complete.

1. Measure total water flow:

a. Position valves for full flow through coils.
b. Measure flow by main flow meter, if installed.

c. If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.

C. For systems with pressure independent valves at terminals:

1. Measure differential pressure and verify that it is within manufacturer's specified range.
2. Perform temperature tests after flows have been verified.

D. For systems without pressure independent valves or flow measuring devices at terminals:

1. Measure and balance coils by either coil pressure drop or temperature method.
2. If balanced by coil pressure drop, perform temperature tests after flows have been verified.

E. Verify final system conditions as follows:

1. Remeasure and confirm that total water flow is within design.
2. Mark final settings.

F. Verify that memory stops have been set.

3.10 PROCEDURES FOR CONDENSING UNITS

A. Verify proper rotation of fans.

B. Measure entering and leaving air temperatures.

C. Record fan and motor operating data.

3.11 VIBRATION TESTS

A. After systems are balanced and construction is Substantially Complete, measure and record vibration levels on equipment having motor horsepower equal to or greater than Seven and a Half (7.5).

B. Instrumentation:

1. Use portable, battery operated, and microprocessor controlled vibration meter with or without a built in printer.
2. The meter shall automatically identify engineering units, filter bandwidth, amplitude, and frequency scale values.
3. The meter shall be able to measure machine vibration displacement in mils of deflection, velocity in inches per second, and acceleration in inches per second squared.
4. Verify calibration date is current for vibration meter before taking readings.

C. Test Procedures:

1. To ensure accurate readings, verify that accelerometer has a clean, flat surface and is mounted properly.
2. With the unit running, set up vibration meter in a safe, secure location. Connect transducer to meter with proper cables. Hold magnetic tip of transducer on top of the bearing, and measure unit in mils of deflection. Record measurement, then move transducer to the side of the bearing and record in mils of deflection. Record an axial reading in mils of deflection by holding nonmagnetic, pointed transducer tip on end of shaft.
3. Change vibration meter to velocity (inches per second) measurements. Repeat and record above measurements.
4. Record CPM or rpm.
5. Read each bearing on motor, fan, and pump as required. Track and record vibration levels from rotating component through casing to base.

D. Reporting:

1. Report shall record location and the system tested.
2. Include horizontal vertical axial measurements for tests.
3. Verify that vibration limits follow Specifications, or, if not specified, follow the General Machinery Vibration Severity Chart or Vibration Acceleration General Severity Chart from the AABC National Standards. Acceptable levels of vibration are normally "smooth" to "good."
4. Include in report General Machinery Vibration Severity Chart, with conditions plotted.

## 3.12 PROCEDURES FOR HEAT TRANSFER COILS

A. Measure, adjust, and record the following data for each water coil:

1. Entering and leaving water temperature.
2. Water flow rate.
3. Water pressure drop for major (more than 20 gpm) equipment coils.
4. Dry bulb temperature of entering and leaving air.
5. Wet bulb temperature of entering and leaving air for cooling coils.
6. Airflow.

B. Measure, adjust, and record the following data for each electric heating coil:

1. Nameplate data.
2. Airflow.
3. Entering and leaving air temperature at full load.
4. Voltage and amperage input of each phase at full load.
5. Calculated kilowatt at full load.
6. Fuse or circuit breaker rating for overload protection.

C. Measure, adjust, and record the following data for each refrigerant coil:

1. Dry bulb temperature of entering and leaving air.
2. Wet bulb temperature of entering and leaving air.
3. Airflow.

3.13 DUCT LEAKAGE TESTS

A. Witness the duct pressure testing performed by Installer.

B. Verify that proper test methods are used and that leakage rates are within specified tolerances.

C. Report deficiencies observed.

3.14 CONTROLS VERIFICATION

A. In conjunction with system balancing, perform the following:

1. Verify temperature control system is operating within the design limitations.
2. Confirm that the sequences of operation are in compliance with Contract Documents.
3. Verify that controllers are calibrated and function as intended.
4. Verify that controller set points are as indicated.
5. Verify the operation of lockout or interlock systems.
6. Verify the operation of valve and damper actuators.
7. Verify that controlled devices are properly installed and connected to correct controller.
8. Verify that controlled devices travel freely and are in position indicated by controller: open, closed, or modulating.
9. Verify location and installation of sensors to ensure that they sense only intended temperature, humidity, or pressure.

B. Reporting: Include a summary of verifications performed, remaining deficiencies, and variations from indicated conditions.

3.15 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

A. Perform a preconstruction inspection of existing equipment that is to remain and be reused.

1. Measure and record the operating speed, airflow, and static pressure of each fan.
2. Measure motor voltage and amperage. Compare the values to motor nameplate information.
3. Check the refrigerant charge.

4. Check the condition of filters.
5. Check the condition of coils.
6. Check the operation of the drain pan and condensate-drain trap.
7. Check bearings and other lubricated parts for proper lubrication.

B. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.

3.16 TOLERANCES

A. Set HVAC system's airflow rates and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10%.
2. Air Outlets and Inlets: Plus or minus 10%.
3. Cooling Water Flow Rate: Plus or minus 10%.

B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.17 PROGRESS REPORTING

A. Initial Construction Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems balancing devices. Recommend changes and additions to systems balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

B. Status Reports: Prepare weekly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.18 FINAL TAB REPORT

A. Final TAB Report: The final TAB report shall be a complete record of the HVAC system performance, including conditions of operation, items outstanding, and any deviations found during the TAB process and serve as a reference of the actual operating conditions of the systems. All measurements and test results that appear in the TAB report must be made on site and dated by the AABC technicians and/or TAB engineer performing the work. This report shall be provided as a complete electronic “pdf” file organized as specified and submitted to the A/E for review.

B. Sign & Seal: Final TAB report shall bear the seal and signature of Test and Balance Engineer. TAB Report shall be certified proof that systems have been tested, adjusted, and balanced in accordance with referenced standards; are an accurate representation of

how systems have been installed; are true representation of how systems are operating at completion of testing, adjusting, and balancing procedures; and are accurate record of final quantities measured, to establish normal operating values of the systems.

END OF SECTION 230593

# SECTION 230700 – INSULATION FOR HVAC SYSTEMS AND EQUIPMENT

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 23.

### 1.2 SUMMARY

A. This section includes the insulation requirements for HAVC pipe and duct systems as follows:

1. Flexible elastomeric insulation.
2. Mineral fiber blanket insulation.
3. Mineral fiber board insulation.
4. Mineral fiber pipe and tank insulation.
5. Cellular glass insulation.
6. Calcium silicate insulation.
7. Adhesives.
8. Mastics.
9. Lagging adhesives.
10. Sealants.
11. Factory applied jackets.
12. Field applied cloths.
13. Field applied jackets.
14. Tapes.
15. Securements.
16. Corner angles.

### 1.3 ACTION SUBMITTALS

A. Product Data: For each specified product, include manufacturers cut sheets, dimensional data, thermal performance data, installation instructions, jackets, specified options, and warranty information.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail insulation application at elbows, fittings, dampers, specialties and flanges for each type of insulation.
3. Detail application of field-applied jackets.

4. Detail application at linkages of control devices.

C. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use. Sample sizes are as follows:

1. Sheet Form Insulation Materials: Twelve (12) inches square.
2. Sheet Jacket Materials: Twelve (12) inches square.
3. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTAL

A. Operation and Maintenance Data: Include a copy of each approved submittal along with any applicable maintenance data in the project operation.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of twenty five (25) or less, and smoke-developed index of fifty (50) or less.
2. Insulation Installed Outdoors: Flame-spread index of seventy five (75) or less, and smoke-developed index of one hundred fifty (150) or less.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.8 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Division 23 Specification Section "Hangers and Supports for HVAC Piping Systems."

B. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.9 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

1.10 WARRANTY/GUARANTEE

A. See Division 23 Specification Section “Basic Mechanical Requirements – HVAC” for warranty and guarantee requirements.

**PART 2 - PRODUCTS**

2.1 GENERAL PRODUCT REQUIREMENTS

A. Equipment Design and Selection: Insulation and accessories shall be designed and selected, for the intended use, in accordance with the details on the drawings and the requirements of this specification.

B. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. Fiberglass, Fiber Board and Cellular Insulation: Subject to compliance with requirements, provide products by one (1) of the following:

a. Owings Corning Inc.
b. John Manville
c. Knauf Inc.

d. Pittsburgh Corning Corporation; Foamglas.

2. Elastromeric Insulation: Subject to compliance with requirements, provide products by one (1) of the following:

a. Armstrong.
b. Armcell
c. Knauf Inc.

3. Adhesives, Mastics, and Sealants: Provide adhesives, mastics and sealant products recommended by the insulation manufacturer or by one (1) of the following:

a. Foster Brand.
b. Fueller Company.
c. Eagle Bridge.

## 2.2 INSULATION MATERIALS

A. Comply with requirements in "Duct Insulation Schedule, General," "Indoor Duct and Plenum Insulation Schedule," and "Aboveground, Outdoor Duct and Plenum Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

## 2.3 FLEXIBLE ELASTOMERIC INSULATION

A. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type II for sheet materials.

## 2.4 MINERAL-FIBER BLANKET INSULATION:

A. Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, TYPE II and ASTM C 1290, TYPE I TYPE III with Factory-Applied FSP Jacket. Factory-Applied Jacket requirements are specified in "Factory-Applied Jackets" article.

B. Products: Subject to compliance with requirements, provide one (1) of the following:

1. Johns Manville; Microlite.
2. Knauf Insulation; Friendly Feel Duct Wrap.
3. Owens Corning; SOFTR All-Service Duct Wrap.

## 2.5 MINERAL-FIBER BOARD INSULATION

A. Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, TYPE IA or TYPE IB. For duct and plenum applications, provide insulation with Factory-Applied ASJ. Factory-Applied Jacket Requirements are specified in "Factory-Applied Jackets" article.

B. Products: Subject to compliance with requirements, provide one (1) of the following:

1. Johns Manville; 800 Series Spin-Glas.
2. Knauf Insulation; Insulation Board.
3. Owens Corning; Fiberglas 700 Series.

## 2.6 MINERAL-FIBER, PIPE AND TANK INSULATION

A. Mineral or glass fibers bonded with a thermosetting resin. Semi rigid board material with factory-applied ASJ complying with ASTM C 1393, TYPE II or TYPE IIIA category 2, or with properties similar to ASTM C 612, TYPE IB. Nominal density is 2.5 LB/CU. FT. or more. Thermal conductivity (k-value) at 100°F is 0.29 BTU X IN./H X SQ. FT. X °F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" article.

B. Products: Subject to compliance with requirements, provide one (1) of the following:

1. Johns Manville; MicroFlex.
2. Knauf Insulation; Pipe and Tank Insulation.
3. Owens Corning; Fiberglas Pipe and Tank Insulation.

## 2.7 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. Products: Subject to compliance with requirements, provide one (1) of the following:

a. Aeroflex USA, Inc.; Aeroseal.
b. Armacell LLC; Armaflex 520 Adhesive.

c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.K-Flex USA; R-373 Contact Adhesive.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Products: Subject to compliance with requirements, provide one (1) of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.Eagle Bridges - Marathon Industries; 225.
b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

D. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Products: Subject to compliance with requirements, provide one (1) of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.Eagle Bridges - Marathon Industries; 225.
b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50.Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

E. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Products: Subject to compliance with requirements, provide one (1) of the following:

a. Dow Corning Corporation; 739, Dow Silicone.
b. Johns Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
c. P.I.C. Plastics, Inc.; Welding Adhesive.
d. Speedline Corporation; Polyco VP Adhesive.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.8 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.

1. Products: Subject to compliance with requirements, provide one (1) of the following**:**

a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.
b. Vimasco Corporation; 749.

2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
3. Service Temperature Range: -20°F to +180°F.
4. Solids Content: ASTM D 1644, 58% by volume and 70% by weight.
5. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.

1. Products: Subject to compliance with requirements, provide one (1) of the following:

    a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-10.
    b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 46-50.

2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
3. Service Temperature Range: -20°F to +180°F.
4. Solids Content: 60% by volume and 66% by weight.
5. Color: White.

## 2.9 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.

1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Products: Subject to compliance with requirements, provide one (1) of the following:

    a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-50 AHV2.Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-36.
    b. Vimasco Corporation; 713 and 714.

3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct insulation.
4. Service Temperature Range: 0°F to +180°F.
5. Color: White.

## 2.10 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one (1) of the following:

    a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.Eagle Bridges - Marathon Industries; 405.
    b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.

c. Mon-Eco Industries, Inc.; 44-05.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: -40°F to +250°F.
5. Color: Aluminum.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. ASJ Flashing Sealants, and Vinyl and PVC Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one (1) of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: -40°F to +250°F.
5. Color: White.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

## 2.11 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

## 2.12 FIELD-APPLIED CLOTHS

A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd.

1. Products: Subject to compliance with requirements, provide one (1) of the following:

a. Alpha Associates, Inc.; Alpha-Maritex 84215 and 84217/9485RW, Luben 59.

2.13 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop cutting and forming. Thickness twenty (20) mil-thick.

1. Products: Subject to compliance with requirements, provide one (1) of the following:

a. Johns Manville; Zeston.
b. P.I.C. Plastics, Inc.; FG Series.
c. Proto Corporation; LoSmoke.
d. Speedline Corporation; SmokeSafe.

2. Adhesive: As recommended by jacket material manufacturer.
3. Color: White.

2.14 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, provide one of the following:
a. ABI, Ideal Tape Division; 428 AWF ASJ.
b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
c. Compac Corporation; 104 and 105.
d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.

2. Width: Four (4) inches.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, provide one (1) of the following:

   a. ABI, Ideal Tape Division; 491 AWF FSK.
   b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
   c. Compac Corporation; 110 and 111.
   d. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.

2. Width: Four (4) inches.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

1. Products: Subject to compliance with requirements, provide one (1) of the following:

   a. ABI, Ideal Tape Division; 370 White PVC tape.
   b. Compac Corporation; 130.
   c. Venture Tape; 1506 CW NS.

2. Width: Four (4) inches (50 mm).

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Products: Subject to compliance with requirements, provide one (1) of the following:

   a. ABI, Ideal Tape Division; 488 AWF.
   b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
   c. Compac Corporation; 120.
   d. Venture Tape; 3520 CW.

2. Width: Four (4) inches (50 mm).

2.15 SECUREMENTS

A. Bands:

1. Products: Subject to compliance with requirements, provide one (1) of the following:

   a. ITW Insulation Systems; Gerrard Strapping and Seals.
   b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.

2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304; 0.015 inch thick, three quarter (3/4) inch wide with wing seal.
3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, three quarter (3/4) inch wide with wing seal.

B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch diameter shank, length to suit depth of insulation indicated.

    a. Products: Subject to compliance with requirements, provide one (1) of the following:

        1) AGM Industries, Inc.; CWP-1.
        2) GEMCO; CD.
        3) Midwest Fasteners, Inc.; CD.
        4) Nelson Stud Welding; TPA, TPC, and TPS.

2. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

    a. Products: Subject to compliance with requirements, provide one (1) of the following:

        1) AGM Industries, Inc.; Tactoo Perforated Base Insul-Hangers.
        2) GEMCO; Perforated Base.
        3) Midwest Fasteners, Inc.; Spindle.

    b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by two (2) inches square.
    c. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
    d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

3. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

a. Products: Subject to compliance with requirements, provide one (1) of the following:

1) GEMCO; Nylon Hangers.
2) Midwest Fasteners, Inc.; Nylon Insulation Hangers.

b. Baseplate: Perforated, nylon sheet, 0.030 inch thick by one and one half (1-1/2) inches in diameter.
c. Spindle: Nylon, 0.106-inch-diameter shank, length to suit depth of insulation indicated, up to two and one half (2-1/2) inches.
d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

4. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than one and one half (1-1/2) inches in diameter.

a. Products: Subject to compliance with requirements, provide one (1) of the following:

1) AGM Industries, Inc.; RC-150.
2) GEMCO; R-150.
3) Midwest Fasteners, Inc.; WA-150.
4) Nelson Stud Welding; Speed Clips.

b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

5. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than one and one half (1-1/2) inches in diameter.

C. Staples: Outward-clinching insulation staples, nominal three quarter (3/4) inch- wide, stainless steel or Monel.

D. Wire: 0.062-inch soft-annealed, stainless steel.

2.16 CORNER ANGLES

A. Material and thickness shall be same as jacket.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

### 3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.

B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Keep insulation materials dry during application and finishing.

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.

2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.

J. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with three (3) inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced four (4) inches o.c.
3. Overlap jacket longitudinal seams at least one and one half (1-1/2) inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at two (2) inches o.c.

    a. For below ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75% of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least four (4) inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.

2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least two (2) inches (50 mm) below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least two (2) inches.
4. Seal jacket to wall flashing with flashing sealant.

C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least two (2) inches.

1. Comply with requirements in Section "Penetration Firestopping" Firestopping and fire-resistive joint sealers.

E. Insulation Installation at Floor Penetrations:

1. Duct: For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least two (2) inches.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Architectural Specification Section "Penetration Fire Stopping."

## 3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes.

Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least two (2) inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

## 3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

## 3.7 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward-clinched staples at six (6) inches o.c.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least one (1) inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.8 INSTALLATION OF EQUIPMENT, TANK, AND VESSEL INSULATION

A. Mineral-Fiber, Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of tank and vessel surfaces.
2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
3. Protect exposed corners with secured corner angles.
4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:

    a. Do not weld anchor pins to ASME-labeled pressure vessels.
    b. Select insulation hangers and adhesives that are compatible with service temperature and with substrate.
    c. On tanks and vessels, maximum anchor-pin spacing is three (3) inches (75 mm) from insulation end joints, and sixteen (16) inches (400 mm) o.c. in both directions.
    d. Do not overcompress insulation during installation.
    e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
    f. Impale insulation over anchor pins and attach speed washers.
    g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately six (6) inches from each end. Install wire or cable between two circumferential girdles twelve (12) inches o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of forty eight (48) inches o.c. Use this network for securing insulation with tie wire or bands.
7. Stagger joints between insulation layers at least three (3) inches.
8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

B. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.

1. Apply 100% coverage of adhesive to surface with manufacturer's recommended adhesive.
2. Seal longitudinal seams and end joints.

## 3.9 DUCT INSULATION

A. Installation Of Flexible Elastomeric Insulation:

1. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Installation Of Mineral-Fiber Insulation:

1. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
2. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50% coverage of duct and plenum surfaces.

3. Revise first subparagraph below to allow adhesive to be omitted from top surface of horizontal rectangular ducts.
4. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
5. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

    a. On duct sides with dimensions eighteen (18) inches and smaller, place pins along longitudinal centerline of duct. Space three (3) inches maximum from insulation end joints, and sixteen (16) inches o.c.
    b. On duct sides with dimensions larger than eighteen (18) inches, place pins sixteen (16) inches o.c. each way, and three (3) inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    d. Do not overcompress insulation during installation.
    e. Impale insulation over pins and attach speed washers.
    f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

6. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing two (2) inches from one (1) edge and one (1) end of insulation segment. Secure laps to adjacent insulation section with one half (1/2) inch outward-clinching staples, one (1) inch (25 mm) o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

    a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
    b. Install vapor stops for ductwork and plenums operating below 50°F at eighteen (18) foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two (2) times the insulation thickness, but not less than three (3) inches.

7. Overlap unfaced blankets a minimum of two (2) inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of eighteen (18) inches o.c.

8. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
9. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with six (6) inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced six (6) inches o.c.

C. Board Insulation Installation On Ducts And Plenums:

1. Secure with adhesive and insulation pins.
2. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50% coverage of duct and plenum surfaces.
3. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
4. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

    a. On duct sides with dimensions eighteen (18) inches and smaller, place pins along longitudinal centerline of duct. Space three (3) inches maximum from insulation end joints, and sixteen (16) inches o.c.
    b. On duct sides with dimensions larger than eighteen (18) inches, space pins sixteen (16) inches o.c. each way, and three (3) inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    d. Do not overcompress insulation during installation.
    e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

5. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing two (2) inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with one half (1/2) inch outward-clinching staples, one (1) inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

    a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
    b. Install vapor stops for ductwork and plenums operating below 50°F at eighteen (18) foot intervals. Vapor stops shall consist of vapor-barrier

mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two (2) times the insulation thickness, but not less than three (3) inches.

6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with six (6) inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced six (6) inches o.c.

## 3.10 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with two (2) inch overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch-thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with one half (1-1/2) inch laps at longitudinal seams and three (3) inch wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

C. Where PVC jackets are indicated, install with one (1) inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

## 3.11 FINISHES

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Architectural Specification Sections for "Exterior Painting" and/or "Interior Painting."

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two (2) coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

3.12 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each duct system defined in the "Duct Insulation Schedule, General" Article.

D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.13 INSULATION SCHEDULES

| INSULATION SCHEDULE - PIPING SYSTEMS | | | | | | |
|---|---|---|---|---|---|---|
| **Pipe System** | **Pipe Size in Inches (NPS)** | **Materials** | **Thickness in Inches** | **Vapor Barrier Required** | **Field Applied Jacket - MER** | **Field Applied Jacket - NON - MER** |
| A/C Condensate Drain Piping - 40ºF - | ½ to 1, Branch Run - outs | Fiberglass<br>Flexible Elastomeric | ½<br>½ | Yes<br>Yes | N / A<br>N / A | None<br>None |
| | ½ to 1 ½ | Fiberglass | 1 | Yes | N / A | None |

| | | | | | | |
|---|---|---|---|---|---|---|
| 110ºF | 2 to 36 | Fiberglass | 1 ½ | Yes | N / A | None |
| A/C Condensate Drain Piping - 40ºF - 110ºF | ½ to 1, Branch Run - outs | Fiberglass<br>Flexible Elastomeric | ½<br>½ | Yes<br>Yes | G C<br>G C | P<br>P |
| | ½ to 1 ½ | Fiberglass | 1 | Yes | G C | P |
| | 2 to 36 | Fiberglass | 1 ½ | Yes | N / A | P |
| Concealed Interior Cold HVAC Piping Systems, 0ºF - 100ºF and Refrigerant Suction | ½ to 2 | Fiberglass<br>Cellular Glass<br>Flexible Elastomeric, Refrigerant Suction only | 1<br>1<br>¾ | Yes<br>Yes<br>Yes | None<br>None<br>None | None<br>None<br>None |
| | 2 ½ to 8 | Fiberglass<br>Cellular Glass | 1 ½<br>1 ½ | Yes<br>Yes | None<br>None | None<br>None |
| | 10 to 36 | Fiberglass<br>Cellular Glass | 2<br>2 | Yes<br>Yes | None<br>None | None<br>None |

| INSULATION SCHEDULE - PIPING SYSTEMS | | | | | | |
|---|---|---|---|---|---|---|
| **Pipe System** | **Pipe Size in Inches (NPS)** | **Materials** | **Thickness in Inches** | **Vapor Barrier Required** | **Field Applied Jacket - MER** | **Field Applied Jacket - NON - MER** |
| Exposed Interior Cold HVAC Piping Systems, 0ºF - 100ºF and Refrigerant Suction | ½ to 2 | Fiberglass<br>Cellular Glass<br>Flexible Elastomeric, Refrigerant Suction only | 1<br>1<br>¾ | Yes<br>Yes<br>Yes | GC<br>GC<br>GC | P<br>P<br>P |
| | 2 ½ to 8 | Fiberglass<br>Cellular Glass | 1 ½<br>1 ½ | Yes<br>Yes | GC<br>GC | P<br>P |
| | 10 to 36 | Fiberglass<br>Cellular Glass | 2<br>2 | Yes<br>Yes | GC<br>GC | P<br>P |

| INSULATION SCHEDULE - EQUIPMENT | | | | | | |
|---|---|---|---|---|---|---|
| **System Equipment** | **Material** | **Form** | **Thickness in Inches** | **Vapor Barrier Required** | **Field Applied Jacket - MER** | **Field Applied Jacket - NON - MER** |
| Exposed Interior Cold HVAC Equipment, Tanks and Pumps, 40ºF - 110ºF | Fiberglass | Block or Board | 2 | Yes | GC | GC |
| | Cellular Glass | Block | 1 ½ | Yes | GC | GC |
| | Flexible Elastomeric | Sheet | 1 | Yes | None | None |

| INSULATION SCHEDULE - DUCT SYSTEMS | | | | | | |
|---|---|---|---|---|---|---|
| **Duct System** | **Material** | **Form** | **Thickness in Inches** | **Vapor Barrier Required** | **Field Applied Jacket - MER** | **Field Applied Jacket - NON - MER** |
| Concealed Interior HVAC Supply and Return Ducts and Plenums | Fiberglass | Blanket | 1 ½ | Yes | None | None |
| Exposed Interior HVAC Supply and Return Ducts and Plenums | Fiberglass<br>Fiberglass | Board - Rectangular or Square<br>Pipe - Round | 1 ½<br>1 ½ | Yes<br>Yes | None<br>None | None<br>None |
| Concealed Interior HVAC Fresh Air Ducts and Plenums | Fiberglass | Blanket | 1 ½ | Yes | None | None |
| Exposed Interior HVAC Fresh Air Ducts and Plenums | Fiberglass | Board - Rectangular or Square | 1 ½ | Yes | None | None |

END OF SECTION 230700

# SECTION 230800 – COMMISSIONING HVAC SYSTEMS
# PART 1 - GENERAL

## 1.1 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 and all other sections of Division 23.

B. The OPR and BOD documentation are included by reference for information only.

## 1.2 SUMMARY

A. This section includes the requirements for commissioning the HVAC systems, assemblies and equipment.

## 1.3 DESCRIPTION

A. The following equipment and/or accessories shall be commissioned as part of this project:

1. Chilled water systems and equipment
2. Air distribution systems and equipment
3. Building automation system
4. Interface connections with the BAS.

## 1.4 ACTION SUBMITTALS

A. Refer to Division 01 Specification Section “COMMISSIONING” for CxA’s role.

B. Refer to Division 01 Specification Section “SUBMITTAL PROCEDURES” for specific requirements.

C. Refer to Division 01 Specification Section “COMMISSIONING” for additional submittal requirements related to submittals of equipment to be commissioned and Cx specific submittals.

## 1.5 COORDINATION

A. Refer to Division 01 Specification Section “COMMISSIONING” for requirements pertaining to coordination during the commissioning process.

## 1.6 GENERAL DOCUMENTATION

A. With assistance from the installing contractors, the CxA will prepare Pre-Functional Checklists for all commissioned components, equipment, and systems.

1.7 WARRANTY/GUARANTEE

A. See Division 23, Specification Section "Basic Mechanical Requirements – HVAC" for warranty and guarantee requirements.

**PART 2 - PRODUCTS**

2.1 TEST EQUIPMENT

A. Refer to Division 01 Specification Section "COMMISSIONING" for requirements pertaining to testing equipment.

**PART 3 - EXECUTION**

3.1 TESTING PREPARATION

A. Certify in writing to the CxA that HVAC systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.

B. Certify in writing to the CxA that HVAC 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 in writing 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. Place systems, subsystems, and equipment into operating mode to be tested (e.g., for pumps and AHU's 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 record test data as directed by the CxA.

3.2 TAB VERIFICATION

A. Notify the CxA at least ten (10) days in advance of testing and balancing Work, and provide access for the CxA to witness testing and balancing Work.

B. Provide technicians, instrumentation, and tools to verify testing and balancing of HVAC systems at the direction of the CxA.

1. The CxA will coordinate with the CM and TAB contractor to determine the date of field verification. Notice will not include data points to be verified.
2. The TAB 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%.
4. Failure of more than 10% of selected items shall result in rejection of final TAB report.
5. TAB contractor shall remedy the deficiency and notify the CxA so verification of failed portions can be performed.

## 3.3 GENERAL TESTING REQUIREMENTS

A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.

B. Scope of HVAC testing shall include entire HVAC installation, from central equipment for heat generation and refrigeration through distribution systems to each conditioned space. 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 HVAC contractor, TAB Subcontractor, and HVAC Instrumentation and Control Subcontractor shall prepare detailed testing plans, procedures, and checklists for HVAC 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 HVAC 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.

3.4 HVAC SYSTEMS, SUBSYSTEMS, AND EQUIPMENT TESTING PROCEDURES

A. Procedures: Where applicable follow manufacturer's written procedures. If no procedures are prescribed by the manufacturer, proceed as follows:

1. HVAC Piping Distribution Systems: Includes chilled water piping systems.

a. Verify that all valves and accessories have been installed correctly, are accessible and operate as intended.
b. Verify that specified leak tests of piping systems are complete.

2. HVAC Air Distribution Systems: Includes supply, return, general exhaust and miscellaneous exhaust duct systems.

a. Verify that all ductwork, air devices, terminal units and accessories have been installed correctly, are accessible and operate as intended.
b. Verify that specified leak tests of duct systems are complete.

3. HVAC Equipment: Includes backflow preventers, electric unit heater, split system ac unit, air handlers, ventilation fans, and exhaust fans.

a. Verify that all equipment has been installed in accordance with the manufactures recommendations and all equipment can be easily accessed for maintenance.

b. Verify that all valves, trim, fittings, controls, and accessories have been installed correctly and operates as intended.
c. Verify that all required interfaces with the BAS have been installed correctly and operates as intended.
d. Operate equipment as intended to ensure the design conditions can be obtained.

4. HVAC Building Automation System:

a. Verify that all control hardware and software, sequences of operations, and integration of factory controls has been installed correctly and operates as intended.
b. Verify that all control valves, trim, fittings, and accessories have been installed correctly and operates as intended.
c. Verify that all equipment test, training, and startup procedures have been completed per the specifications.
d. Verify that all required interfaces between the BAS and HVAC equipment have been installed correctly and operates as intended.
e. Verify that all control graphics and programming has been installed in accordance with the manufactures recommendations and operates as intended.
f. Operate equipment as intended to ensure the design conditions can be obtained.

END OF SECTION 230800

# SECTION 230900 – BUILDING AUTOMATION SYSTEM

## PART 1 – GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this section and all other sections of Division 23.

### 1.2 SUMMARY

A. This section includes the requirements for the BAS System for renovation projects and includes labor, materials, tools, equipment, transportation, insurance, temporary protection, supervision and incidental items essential for proper installation and operation, even though not specifically mentioned or indicated on the drawings but which are usually provided or are essential for proper installation and operation of systems related to this Section, as indicated on the drawings and specified herein.

B. The specifications and drawings describe the minimum requirements for the installation of work, for automation systems and for equipment shown on the drawings.

C. The Building Automation System (BAS) shall include the following systems:

1. Automatic Temperature Control (ATC)

### 1.3 REFERENCES

A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work of this Section, and are hereby incorporated into, and made a part of the Contract Documents.

B. Material standards shall be as specified or detailed hereinafter and as follows:

1. NFPA 70 – National Electric Code, latest edition adapted by the State of Maryland.
2. UL-916 – Energy Management Systems.
3. UL-873 – Temperature Indication and Regulating Equipment.
4. FCC; Part 15, Subpart J – Class A computing Equipment.
5. UL-864 – Fire and Smoke Control.

### 1.4 ACTION SUBMITTALS

A. Product Data: Provide data for each system component and software module.

1. See Division 1 – Shop Drawings, Product Data and Samples for submittal procedures.

B. Shop Drawings:

1. Shop drawings shall have clearly marked the appropriate specification number or drawing designation, for identification of the submittal.
2. Disposition of shop drawings shall not relieve the Contractor from the responsibility for deviations from the drawings or specifications, unless he has submitted in writing a letter itemizing or calling attention to such deviations at time of submission and secured written approval from the University's Representative, nor shall such disposition of shop drawings relieve the Contractor from responsibility for error in shop drawings or schedules.
3. Shop drawings shall include, but shall not be limited to, the following:

a. Control drawings with detailed piping and wiring diagrams, including bill of material and sequence of operation for automation systems and interfaces with other manufacturers' package systems and BAS.
b. Panel layouts and nameplate lists for local and central panels.
c. Valve and damper schedules showing size, configuration, capacity and location of equipment.
d. Data sheets for all control system components.
e. Control strategies (software programs) must be included within the second shop drawing submittal. The listing of each strategy must be in English and demonstrate the desired sequence of operation. Submittal must be complete with proposed schedules, listing of setpoints and end device point listing and addresses.

1.5 INFORMATIONAL SUBMITTAL

A. Manufacturer's Installation Instructions: Indicate manufacturer's installation instructions for manufactured components.

1.6 CLOSEOUT SUBMITTAL

A. Project Record Documents: Record actual locations of control components, including control units, thermostats and sensors.

1. Revise shop drawings to reflect actual installation and operating sequences.
2. Include submittals data in final "Record Documents" form.

B. Operations and Maintenance Data: Include a copy of the final approved submittal for each product in the operation and maintenance manuals.

1. Include interconnection wiring diagrams complete field installed systems with identified and numbered, system components and devices.
2. Include keyboard illustrations and step-by-step procedures indexed for each operator function.
3. Include inspection period, cleaning methods, cleaning materials recommended and calibration tolerances.

C. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in University's name and registered with manufacturer.

1.7 QUALITY ASSURANCE

A. Manufacturer: Company specializing in manufacturing the products specified in this section with minimum ten (10) years of documented experience.

B. Installer: Company specializing in executing the scope of work specified in this section with minimum ten (10) years of documented experience and approved by the BAS manufacturer.

C. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. and testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

1.8 MAINTENANCE SERVICE

A. Provide service and maintenance of energy management and control systems for two (2) year from Date of Substantial Completion.

B. Provide two (2) complete inspections during the two (2) years; one (1) in each season, to inspect, calibrate and tune controls as required and submit written reports.

1.9 PROTECTION OF SOFTWARE RIGHTS

A. Prior to delivery of software, the University and the party providing the software shall enter into a software license agreement with provisions for the following:

1. Limiting use of software to equipment provided under these specifications.
2. Limiting copying.
3. Preserving confidentiality.
4. Prohibiting transfer to a third party.

1.10 SYSTEM DESCRIPTION

A. Furnish and install and program a total building management automation and automatic temperature control system, hereinafter referred to as the BAS, as manufactured by their corporation.

B. The system components shall be as follows:

| | Device | | Type |
|---|---|---|---|
| 1. | Unit Heaters | | |
| | a. | Logic | DDC |
| | b. | Actuation | Electronic |
| 2. | Self Contained Air Handling Units | | |
| | a. | Logic | Integral by Unit Manufacturer |
| | b. | Actuation | Electronic |
| 3. | Supplemental A/C Units | | |
| | a. | Logic | Integral by Unit Manufacturer |
| | b. | Actuation | Electronic |

C. Microprocessor components shall be as manufactured or approved by the BAS Contractor. Control system shall be installed by competent control mechanics, electricians and technicians regularly employed by the equipment manufacturer.

D. Provide electric wiring and connections as required for all systems.

E. The BAS manufacturer shall be responsible for the coordination, of systems or equipment provided by others that interface with the BAS System.

F. Review all HVAC drawings and the specifications to understand equipment and system operations and to verify quantities and types of dampers, operators, alarms, sensors and monitors. Numerous references to the BAS are made throughout this specification identifying work to be performed under this Section, in addition to work specifically indicated herein.

G. Except as otherwise noted, the control system provided shall consist of microprocessors, transmission network, digital system controllers, central monitoring and control system I/O devices, software, sensors, transducers, relays, thermostats, dampers, damper operators, control panels, other accessory equipment, along with a complete system of electrical interlocking wiring to fill the intent of the specification and provide for a complete and operable system. All control equipment shall be fully proportioning. Except as otherwise specified, provide operators for equipment such as dampers, where such operators are not required to be provided by the equipment manufacturers.

H. Interlock wiring and installation of control devices associated with the air handling units, etc., shall be provided under this Section. When the DDC system is fully installed and operational, the BAS manufacturer, Contractor and University's Representative will review the operation and check out the system. At this time the BAS Manufacturer and Contractor shall demonstrate to all present the operation of the system and prove that it complies with the intent of the drawings and specifications.

I. The BAS scope of work shall include the following:

1. Building Automation System commissioning and acceptance procedures.
2. Equipment labels and graphic designations.
3. Operation and maintenance manuals.
4. Instructional classes on equipment and systems operation for University's facilities personnel.
5. Testing of systems.

J. System Overview:

1. The Building Automation System shall be capable of integrating multiple building functions including equipment supervision and control, alarm management, energy management, and historical data collection and archiving.
2. The Building Automation System (BAS) shall consist of the following:

    a. A complete and fully operation DDC system.
    b. Communication transmission network (hard-wired topography).
    c. Power wiring, temperature control, and remote monitoring.
    d. Operator workstations.

3. The system shall be modular in nature, and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, stand-alone DDC panels, and operator devices.
4. System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution. Each DDC panel shall operate independently by performing its own specified control, alarm management, operator I/O and historical data collection. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.
5. Stand-alone DDC panels shall be able to access any data from, or send control commands and alarm reports directly to any other DDC panel or combination of panels on the network without dependence upon a central processing device.
6. Workstation/DDC Panel Support:

    a. Operator workstations and DDC panels shall directly reside on a local area network such that communications may be executed directly between

controllers, directly between workstations, and between controllers and workstations on a peer-to-peer basis.

7. Dynamic Data Access:

   a. Operator devices, either network resident or connected via dial-up modems, shall have the ability to access point status and application report data, or execute control functions for any other devices via the local area network. Access to data shall be based upon logical identification of building equipment.
   b. Access to system data shall not be restricted by the hardware configuration of the building automation system. The hardware configuration of the BAS network shall be totally transparent to the user when accessing data or developing control programs.

8. General Network Design:

   a. Network design shall include the following provisions:

      1) High speed data transfer rates for alarm reporting, quick report generation from multiple controllers, and upload/download efficiency between network devices. The minimum baud rate shall be 19,200.
      2) Support of any combination of controllers, and operator workstations directly connected to the local area network. A minimum of fifty (50) devices shall be supported on a single local area network.
      3) Detection and accommodation of single or multiple failures of either workstations, DDC panels or the network media. The network shall include provisions for automatically reconfiguring itself to allow operational equipment to perform their designated functions as effectively as possible in the event of single or multiple failures.
      4) Message and alarm buffering to prevent information from being lost.
      5) Error detection, correction, and retransmission to guarantee data integrity.
      6) Default device definition to prevent loss of alarms or data, and ensure alarms are reported as quickly as possible in the event an operator device does not respond.
      7) Commonly available, multiple sourced, networking components and protocols shall be used to allow the BAS to coexist with other networking applications such as office automation. ETHERNET and Siemens Protocol II are campus standard technologies.

8) Use of an industry standard IEEE 802.x protocol. Communications must be of a deterministic nature to assure calculable performance under worst case network loading.
9) Synchronization of the real-time clocks in all DDC panels.

9. System Configuration/Architecture:

a. In general, the actual number of stand-alone DDC panel(s) shall be determined by the actual, "realistic" point capacity of each panel's capacity.
b. As a minimum, each supply air handling unit (AHU) shall be equipped with one stand-alone DDC panel.

10. Existing Central Control and Monitoring System:

a. The Existing Central Control Monitoring System (CCMS) for UMB's Campus operates on software developed by Siemens and/or Johnson Controls. Modifications to the Building Automation System (BAS) shall be an extension of and integration into one of these CCMS Systems as directed by UMB.
b. The existing CCMS shall be expanded to include all CCMS workstations, software and connected field panels for this project.
c. The BAS contractor shall provide any upgrades or software revisions necessary and/or available at the time of connection of this project to bring the entire venders CCMS up to current product and software offering. The BAS contractor shall provide training and documentation on any new software revisions, their operation and functionality prior to implementation.
d. It is the intent of this specification the BAS contractor, provide their current GUI application software and server/client hardware for the main CCMS system during the construction and connect this project to that system.
e. Providing a third system is not acceptable.

11. Existing University Utility Management System:

a. The existing Utility Management System server resides in the Facilities Operations Center. This system utilizes the Universities wide area network to gather and process data supplied by utility meters and chiller plants sensors connected to the Campus Chilled Water Loop.
b. The BAS Contractor shall expand the Utility Management System (UMS) to include the data points on the Input/Output Summary identified as "Connected to Existing Utility Management System".

12. Agency Approvals:

a. The entire control system shall be UL approved and listed (UL-916 Energy Management and UL-864 Fire Control) for serial interface between the Building Automation System and Fire Alarm System.

1.11 INCIDENTAL WORK SPECIFIED IN OTHER SECTIONS

A. Work specified in the mechanical specifications:

1. Install automatic temperature control valves furnished by BAS Manufacturer.
2. Install pressure taps and sensing wells furnished by BAS Manufacturer.
3. Install steam, hot water, and chilled water meters furnished by BAS Manufacturer.
4. Provide access doors in ductwork as required for access to control equipment.
5. Furnish access panels for installation in walls and ceiling as required for access to concealed control equipment.

B. Work specified in the electrical specifications:

1. Provide power wiring to junction boxes (one 120V/20A circuit per junction box) located above ceiling and as indicated on the electrical drawings. Power wiring from these junction boxes to DDC panels, equipment controllers, sensors, and monitors shall be as specified in this section.
2. Provide power wiring as indicated on the Electrical drawings.

1.12 ELECTRICAL WIRING (BAS)

A. Electric wiring, wiring connections and interlock wiring required for the installation of the building automation system, as herein specified, shall be provided as specified in this section, unless specifically shown on the Electrical drawings or called for in the Electrical specifications. Electrical power requirements, including junction boxes, for all BAS control devices and equipment shall be provided by the electrical contractor as indicated on the electrical drawing and in the electrical specifications. Extension of power wiring from junction boxes to control devices shall be provided by the BAS contractor.

B. Coordinate necessary auxiliary contacts on magnetic starters with the requirements in the electrical specifications.

C. Furnish labor and material to install the necessary wiring to accomplish the successful and complete operation of the new automation system (DDC).

D. Furnish labor and material to install necessary relays, general purpose enclosures and appurtenances to control designated devices relative to the BAS.

E. Wiring throughout shall be concealed where possible.

F. Conduit used shall be EMT, three quarter (3/4) inch minimum size. Conduit sizes shall be large enough to permit the individual conductors to be readily installed or withdrawn without damage to the conductors or their insulation. Splicing of wires will be permitted only in junction boxes or pull boxes.

G. Conduit is never to be relied upon for a fault current and safety ground return conductor.

H. The ground system must never be used as a current carrying conductor except for faults and noise suppression. The stand-alone DDC panel grounding system shall be used to control noise and transients which might affect the operation of the automation system. As such, the ground requirements are in excess of a grounding system used solely for minimum physical protection.

I. The bond to ground shall be as short as possible. A ground point shall be derated by one (1) point (in order of preference) for each fifty (50) feet of conductor run between it and the automation equipment to be grounded. Therefore, a water pipe bond located ten (10) feet away will be preferable to a structural steel bond located one hundred fifty (150) feet away.

J. Set screw connectors shall be galvanized or plated steel. White metal cast type will not be permitted.

K. Flexible conduit shall be used at field devices, including, pressure switches, flow switches and temperature sensors. Convolutions shall be steel, interlocked continuously. Aluminum will not be permitted. "Liquidtight" or equal shall be used in wet locations.

L. Only core drilling is permitted to pierce the floors in the electrical closets and elsewhere. The use of water for drilling shall be controlled by a suitable vacuum system, using proper dams to prevent damage to floors below.

M. Low voltage wiring in exposed areas, outside air plenums, mechanical/electrical rooms and areas which may be subject to mechanical abuse shall be run in EMT or as noted below:

| | | |
|---|---|---|
| 1. | Sensor to Panel (Stud Wall) | EMT in Wall |
| 2. | Sensor to Panel (Mechanical Room) | In New Conduit/EMT |
| 3. | Panel to Operator Workstation within New Building | In New Conduit/EMT |

N. Wiring:

1. Control wiring, low voltage, 20 AWG pair
2. Control wiring, 120VAC, 14 AWG pair
3. Local area network, LAN, 18 AWG twisted shielded pair
4. Building network, 24 AWG, pair, low capacitance type

O. Low voltage wiring not used for life safety/smoke control applications, above suspended ceilings and in accessible concealed areas may be plenum rated cable.

P. Wiring used for life safety/smoke control shall be in EMT or flexible metal clad conduit. Air handling unit controls, including wiring from Fire Command Center to AHU control panel shall be in EMT.

Q. Do not permit the shield from different signal cables to come in contact with each other and make sure that adequate isolation and insulation have been provided.

R. Transmission Network:

1. Network Configuration: The network configuration shall be a hardwired topography.
2. System Capabilities: The new network shall be 100% compatible with a hardwired based network. No additional or third party software bridges shall be required.
3. Server Client Network shall use UM CCMS, CFMS wide area network for connection of the building work station to the server at the operation centers.
4. Use CCMS, CFMS wide area network for connection of field panels to network server.
5. The UMS shall use the CFMS wide area network to communicate to the UMS server located in the Operations Center. Provide all field data gathering panels and data points necessary to meet the Input/output summary and sequence of operation.

S. At every DDC control panel, application specific controller, and terminal unit controller (such as UH's, AC units, etc.) provide a low voltage toggle-type disconnect switch in the incoming 24 VAC service line. Switch to be mounted in a junction box.

1.13 WARRANTY/GUARANTEE

A. See Division 23 Specification Section "Basic Mechanical Requirements – HVAC" for warranty and guarantee requirements.

B. Furnish to the University a written guarantee for field programmable microprocessor based units against all defects in materials and workmanship, including without limitation against hardware failure for two (2) years from date of acceptance. Guarantee shall include all parts and labor. See Division 01, Guarantees, Warranties, Bonds, Service and Maintenance Contracts, for submittal form.

**PART 2 – PRODUCTS**

2.1 GENERAL PRODUCT REQUIREMENTS

A. Equipment Design and Selection: All BAS equipment and accessories shall be designed and selected, for the intended use, in accordance with the scheduled capacities on the drawings and the requirements of this specification.

B. The BAS manufacturer and installer shall be Siemens Building Technologies unless otherwise directed by UMB.

C. Replacement of Existing field Panels: Where existing field panels are considerd obsolete/retired (building controllers, equipment controllers, and floor level network controllers), the BAS contractor shall include in his bid the cost to replace the existing obsolete/retired field panels with new field panels. The cost shall include all modifications to the graphics and programming resulting from this change. The obsolete/retired field panels are located in Bressler Research building and Howard Hall as follows:

1. Bressler Research building: Existing Panel – "BMBC09" Lower Level Mechanical Equipment Room. This panel is a modular building controller/retired. UMB request the project perform a fast forward on this field panel and all the BAS points for this project will come from this newly updated field panel.
2. Howard Hall: Existing Panel – "HMBC09 – AEM" First Floor Mechanical Equipment Room, #129. This panel is a modular building controller/retired. UMB request the project perform a fast forward on this field panel. An existing multi-point unit (MPU-retired) exists in the mailroom in the basement loading dock. This expansion panel will also need be upgraded as part of the project. All new BAS control points for Howard Hall substation project will come out of the basement expansion panel located in mechanical room with mailroom AHU.

2.2 SOFTWARE

A. General: Provide all necessary software to form a complete operating system as described in this specification. The software programs specified in this section shall be provided as an integral part of the DDC panel and shall not be dependent upon any higher level computer for execution.

B. Control Software Description:

1. Pre-Tested Control Algorithms: The DDC panels shall have the ability to perform the following pre-tested control algorithms:

a. Two (2) Position Control
b. Proportional Control
c. Proportional plus Integral Control
d. Proportional, Integral, plus Derivative Control
e. Automatic Control Loop Tuning

2. Equipment Cycling Protection: Control software shall include a provision for limiting the number of times each piece of equipment may be cycled within any one (1) hour period.
3. Heavy Equipment Delays: The system shall provide protection against excessive demand situations during start-up periods by automatically introducing time delays between successive start commands to heavy electrical loads.
4. Powerfail Motor Restart: Upon the resumption of normal power, the DDC panel shall analyze the status of controlled equipment, compare it with normal occupancy scheduling, and turn the preselected equipment on or off as necessary in a staggered/time-delayed manner to avoid excess electrical surge. The remainder of the equipment will not automatically start. The system will print out the assigned status of the equipment on the alarm printer. The system shall require a manual command to start any equipment.
5. 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.
6. The system shall be provided complete with equipment and documentation necessary to allow an operator to independently perform the following functions:

    a. Add/delete/modify stand-alone DDC Controller panels
    b. Add/delete/modify operator workstations
    c. Add/delete/modify application specific controllers
    d. Add/delete/modify points of any type and all associated point
    e. Add/delete/modify alarm reporting definition for points
    f. Add/delete/modify control loops
    g. Add/delete/modify energy management applications
    h. Add/delete/modify time and calendar-based programming
    i. Add/delete/modify totalization for points
    j. Add/delete/modify historical data trending for points
    k. Add/delete/modify custom control processes
    l. Add/delete/modify any and all graphic displays, symbols and cross-reference to point data
    m. Add/delete/modify dial-up telecommunication definition
    n. Add/delete/modify all operator passwords
    o. Add/delete/modify alarm messages

7. Definition of operator device characteristics, DDC Controllers individual points, applications and control sequences shall be performed using instructive prompting software.

    a. Field Panel Programs shall be manufacturers' standard line program method.
    b. Inputs and outputs for any process shall not be restricted to a single DDC Controller. Each Controller shall be able to include data from other

network panels to allow the development of network-wide control strategies. Processes shall also allow the operator to use the results of one process as the input to any number of other processes (cascading).

c. Provide the capability to backup and store system databases on the workstation hard disk. In addition, database changes shall be performed while the workstation is on-line without disrupting other system operations. Changes shall be automatically recorded and downloaded to the appropriate DDC Controller. Similarly, changes made at the DDC Controllers shall be automatically uploaded to the workstation, ensuring system continuity. The user shall also have the option to selectively download changes as desired.

d. Provide context-sensitive help menus to provide instructions appropriate with operations and applications currently being performed.

C. Energy Management Applications: DDC Panels shall have the ability to perform any or all of the following energy management routines:

1. Time of Day Scheduling
2. Calendar Based Scheduling
3. Holiday Scheduling
4. Temporary Schedule Overrides
5. Optimal Start
6. Optimal Stop
7. Optimal Stop
8. Night Setback Control
9. Peak Demand Limiting
10. Temperature Compensated Load Rolling
11. Variable frequency drive/CFM Control
12. Heating/Cooling Interlock
13. Discharge Air Temperature Reset Based Optimized Reheat Coil Positions and Maximum Space Humidity Setpoint
14. Chilled Water Reset

D. Custom Process Programming Capability: DDC panels shall be able to execute custom, job-specific processes defined by the user, to automatically perform calculations and special control routines.

1. Process Inputs and Variables: It shall be possible to use any of the following in a custom process:

a. Any system-measured point data or status
b. Any calculated data
c. Any results from other processes
d. User-Defined Constants
e. Arithmetic functions (+,-,*,/, square root, exp, etc.)

f. Boolean logic operators (and, or, exclusive or, etc.)
g. On-delay/Off-delay/One-shot timers

2. Process Triggers: Custom processes may be triggered based on any combination of the following:

a. Time interval
b. Time of day
c. Date
d. Other processes
e. Time programming
f. Events (e.g., point alarms)

3. Dynamic Data Access: A single process shall be able to incorporate measured or calculated data from other DDC panels on the local area network. In addition, a single process shall be able to issue commands to points in other DDC panels on the local area network.
4. Advisory/Message Generation: Processes shall be able to generate operator messages and advisories to operator I/O devices. A process shall be able to directly send a message to a specified device, buffer the information in a follow-up file, or cause the execution of a dial-up connection to a remote device such as a printer or pager.
5. Custom Process Documentation: The custom control programming feature shall be self-documenting. All interrelationships defined by this feature shall be documented via graphic flow charts and English language descriptors.

E. Alarm Management: Alarm management shall be provided to monitor, print, buffer, and direct alarm reports to operator devices and memory files. Each DDC panel shall perform distributed, independent alarm analysis and filtering to minimize operator interruptions due to non-critical alarms, minimize network traffic, and prevent alarms from being lost. At no time shall the DDC panel's ability to report alarms be affected by either operator activity at a PC Workstation or local I/O device, or communications with other panels on the network..

1. Point Change Report Description: Alarm or point change reports shall include the point's English language description and the time and date of occurrence.
2. Prioritization: The user shall be able to define the specific system reaction for each point. Alarms shall be prioritized to minimize nuisance reporting and to speed operator response to critical alarms. A minimum of three (3) priority levels shall be provided. Each DDC panel shall automatically inhibit the reporting of selected alarms during system shutdown and start-up. Users shall have the ability to manually inhibit alarm reporting for each point. The user shall also be able to define under which conditions point changes need to be acknowledged by an operator, and/or sent to follow-up files for retrieval and analysis at a later date.

3. Report Routing: Alarm reports, messages, and files will be directed to a user-defined list of operator devices, or PC's used for archiving alarm information.

   a. Alarms shall also be automatically directed to a default device in the event a primary device is found to be off-line.

4. Alarm Messages: In addition to the point's descriptor and the time and date, the user shall be able to print, display or store a two hundred (200) character alarm message for each system point to more fully describe the alarm condition or direct operator response. Each stand-alone DDC panel shall be capable of storing a library of at least two hundred fifty (250) alarm messages. Each message may be assignable to any number of points in the panel.

F. Historical Data and Trend Analysis: A variety of Historical data collection utilities shall be provided to automatically sample, store, and display system data in the following ways.

1. Continuous Point Histories: Stand-alone DDC panels shall store Point History Files for analog and binary inputs and outputs. The Point History routine shall continuously and automatically sample the value of analog inputs at half hour intervals. Samples for points shall be stored for the past twenty four (24) hours to allow the user to immediately analyze equipment performance and problem-related events for the past day. Point History Files for binary input or output points and analog output points shall include a continuous record of the last ten (10) status changes or commands for each point.
2. Control Loop Performance Trends: Stand-alone DDC panels shall also provide high resolution sampling capability with an operator-adjustable resolution of ten (10) to three hundred (300) seconds in one (1) second increments for verification of control loop performance.
3. Extended Sample Period Trends: Measured and calculated analog and binary data shall also be assignable to user-definable trends for the purpose of collecting operator-specified performance data over extended periods of time. Sample intervals of one (1) minute to two (2) hours, in one (1) minute intervals, shall be provided. Each stand-alone DDC panel shall have a dedicated buffer for trend data and shall be capable of storing a minimum of 10,000 data samples.
4. Data Storage and Archiving: Trend data shall be stored at the Stand-alone DDC panels, and uploaded to hard disk storage (minimum 80 megabyte) when archival is desired. Uploads shall occur based upon either user-defined interval, manual command, or when the trend buffers become full. Trend data shall be available in disk file form for use in 3rd Party personal computer applications.

G. Runtime Totalization: Stand-alone DDC panels shall automatically accumulate and store runtime hours for binary input and output points as specified in the Execution portion of this specification.

1. The Totalization routine shall have a sampling resolution of (1) minute or less.
2. The user shall have the ability to define a warning limit for Runtime Totalization. Unique, user-specified messages shall be generated when the limit is reached.

H. Analog/Pulse Totalization: Stand-alone DDC panels shall automatically sample, calculate and store consumption totals on a daily, weekly, or monthly basis for user-selected analog and binary pulse input-type points.

1. Totalization shall provide calculation and storage of accumulations of up to 99,999.9 units (e.g. KWH, gallons, KBTU, tons. etc.).
2. The Totalization routine shall have a sampling resolution of one (1) minute or less.
3. The user shall have the ability to define a warning limit. Unique, user-specified messages shall be generated when the limit is reached.

I. Event Totalization: Stand-alone DDC panels shall have the ability to count events such as the number of times a pump or fan system is cycled on and off. Event totalization shall be performed on a daily, weekly, or monthly basis.

1. The Event Totalization feature shall be able to store the records associated with a minimum of 9,999,999 events before reset.
2. The user shall have the ability to define a warning limit. Unique, user-specified messages shall be generated when the limit is reached.

## 2.3 STAND-ALONE DDC PANELS

A. General: Stand-alone DDC panels shall be microprocessor based multi-tasking, multi-user, real-time digital control processors. Each stand-alone DDC panel shall consist of modular hardware with plug-in enclosed processors, communication controllers, power supplies, and input/output modules. A sufficient number of controllers shall be supplied to fully meet the requirements of this specification and drawings.

B. Building Controllers: Building controllers shall include the following:

1. Building Controllers shall be 32 bit, multi-tasking, multi-user, real-time 100 MHz digital control processors consisting of modular hardware with plug-in enclosed processors, communication controllers, power supplies and input/output point modules. Controller size shall be sufficient to fully meet the requirements of this specification and the attached point list.
2. Each Building Controller shall have sufficient memory, a minimum of twenty four (24) megabyte, to support its own operating system and databases, including control processes, energy management applications, alarm management applications, historical/trend data for points specified, maintenance support applications, custom processes and operator I/O.
3. Building Controller shall have an integral real-time clock.

4. Each Building Controller shall support firmware upgrades without the need to change hardware.
5. Each Building Controller shall support:

    a. Monitoring of industry standard analog and digital inputs, without the addition of equipment outside the Building Controller cabinet.
    b. Monitoring of industry standard analog and digital outputs, without the addition of equipment outside the Building Controller cabinet.

6. Spare Point Capacity. Each Building Controller shall have a minimum of 10 percent spare point capacity.

    a. The type of spares shall be in the same proportion as the implemented I/O functions of the panel, but in no case shall there be less than one spare of each implemented I/O type.
    b. Provide all processors, power supplies, and communication controllers so that the implementation of adding a point to the spare point location only requires the addition of the appropriate:

        1) Expansion modules
        2) Sensor/actuator
        3) Field wiring/tubing

7. Serial Communication: Building Controllers shall provide at least one EIA-232C serial data communication ports for operation of operator I/O devices such as industry standard printers, operator terminals, and portable laptop operator's terminals. Building Controllers shall allow temporary use of portable devices without interrupting the normal operation of permanently connected printers or terminals. A USB port shall alternatively be available to support local HMI tools connection.
8. I/O Status and Indication: Building Controllers shall provide local LED 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. Graduated intensity LEDs or analog indication of value shall also be provided for each analog output. All wiring connections shall be made to field-removable terminals.
9. Self-Diagnostics: Each Building Controller shall continuously perform self diagnostics, communication diagnosis, and diagnosis of all panel components. The Building Controller shall provide both local and remote annunciation of any detected component failures, low battery conditions or repeated failure to establish communication for any system.
10. 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 one hundred (100) hours.

11. Environment: Controller hardware shall be suitable for the anticipated ambient conditions as follows:

    a. 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).
    b. 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).

12. Immunity to power and noise.

    a. Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage.
    b. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 1 m (3 ft).
    c. Isolation shall be provided at all primary network terminations, as well as all field point terminations to suppress induced voltage transients consistent with:

        1) RF-Conducted Immunity (RFCI) per ENV 50141 (IEC 1000-4-6) at 3 V.
        2) Electro Static Discharge (ESD) Immunity per EN 61000-4-2 (IEC 1000-4-2) at 8 kV air discharge, 4 kV contact.
        3) Electrical Fast Transient (EFT) per EN 61000-4-4 (IEC 1000-4-4) at 500 V signal, 1 kV power.
        4) Output Circuit Transients per UL 864 (2,400V, 10A, 1.2 Joule max).

    d. Isolation shall be provided at all Building Controller's AC input terminals to suppress induced voltage transients consistent with:

        1) IEEE Standard 587 1980.
        2) UL 864 Supply Line Transients.
        3) Voltage Sags, Surge, and Dropout per EN 61000-4-11 (EN 1000-4-11).

13. Minimum Approved Building Controllers. BAS Contractors shall furnish Building Controllers as listed below. Providing an approved controller does not release the contractor from meeting all performance, software and hardware specifications for Building Controllers and system operations.

    a. Siemens Building Technologies Inc. – PXC Compact and PXC Modular Building Controllers, Modular Building/Modular Equipment Controllers (MBC/MEC).

2.4 BUILDING AND APPLICATION SPECIFIC CONTROLLERS (ASC)

A. General: Provide building and application specific controllers to control each piece of equipment , including, but not limited to the following:

1. Each Building Controller shall be able to communicate with application specific controllers (ASCs) over the Secondary Network to control terminal equipment only.
2. The use of Secondary Network controllers with custom program applications to control AHU's, water systems, etc. is not acceptable.
3. Each ASC shall operate as a stand-alone controller capable of performing its specified control responsibilities independently of other controllers in the network. Each ASC shall be a microprocessor-based, multi-tasking, real-time digital control processor.
4. Each ASC shall include all point inputs and outputs necessary to perform the specified control sequences. The ASC shall accept input and provide output signals that comply with industry standards. Controllers utilizing proprietary control signals shall not be acceptable. Outputs utilized either for two-state, modulating floating, or proportional control, allowing for additional system flexibility.
5. Communication: Each controller shall perform its primary control function independent of other Secondary Network communication, or if Secondary Network communication is interrupted. Reversion to a fail-safe mode of operation during Secondary Network interruption is not acceptable.
6. Control Algorithms: The controller shall receive its real-time data from the Building Controller time clock to insure Secondary Network continuity. Each controller shall include algorithms incorporating proportional, integral and derivative (PID) gains for all applications. All PID gains and biases shall be field-adjustable by the user via room sensor LCD or the portable operator's terminal as specified herein. Controllers that incorporate proportional and integral (PI) control algorithms only shall not be acceptable.
7. Control Applications: Operating programs shall be field-selectable for specific applications. In addition, specific applications may be modified to meet the user's exact control strategy requirements, allowing for additional system flexibility. Controllers that require factory changes of all applications are not acceptable.
8. Calibration: Each controller shall include provisions for manual and automatic calibration of the differential pressure transducer in order to maintain stable control and insuring against drift over time.

    a. Manual calibration may be accomplished by either commanding the actuator to 0% via the POT or by depressing the room sensor override switch. Calibration of the transducer at the controller location shall not be necessary
    b. Calibration shall be accomplished by stroking the terminal unit damper actuator to a 0% position so that a 0 CFM air volume reading is sensed.

The controller shall automatically accomplish this whenever the system mode switches from occupied to unoccupied or vice versa.

c. Calibration shall be accomplished by zeroing out the pressure sensor and holding damper at last known position until calibration is complete. The controller shall automatically accomplish this whenever the system mode switches from occupied to unoccupied or vice versa.

9. Memory: Memory requirements shall include the following requirements:

a. Provide each ASC with sufficient memory to accommodate point databases, operating programs, local alarming and local trending. All databases and programs shall be stored in non-volatile EEPROM, EPROM and PROM, or minimum of seventy two (72) hour battery backup shall be provided. The controllers shall be able to return to full normal operation without user intervention after a power failure of unlimited duration.

b. Upon replacement, new ASCs shall recover control function and site specific defaults automatically and resume normal operation.

10. Power Supply: The ASCs shall be powered from a 24 VAC source and shall function normally under an operating range of 18 VAC to 28 VAC, allowing for power source fluctuations and voltage drops. Power supply for the ASC must be rated at a minimum of 125% of ASC power consumption and shall be of the fused or current limiting type. The BMS contractor shall provide 24 VAC power to the terminal units by utilizing:

a. The existing line voltage power trunk and installing separate isolation transformers for each controller.

b. Dedicated line voltage power source and isolation transformers at a central location and installing 24 VAC power trunk to supply multiple ASCs in the area.

11. Environment: The controllers shall function normally under ambient conditions of 32°F to 122°F (0°C to 50°C) and 10% to 95%RH (non-condensing). Provide each controller with a suitable cover or enclosure to protect the circuit board assembly.

12. Immunity to noise: Operation shall be protected against electrical noise of 5-120 Hz and from keyed radios up to 5 W at 1 m (3 ft).

13. Manufacturer Installed Controls: Include the following:

a. BAS manufacturer shall furnish ASC and actuator for factory mounting to equipment manufacturer.

b. Cost of factory mounting shall be borne by equipment manufacturer.

## 2.5 TEMPERATURE SENSORS (DDC)

A. General: Provide temperature sensors for controllers performing space temperature control. Sensors shall be wired thermistor type, with the following features:

1. Accuracy: + .5°F.
2. Operating Range: 35°F to 115°F.
3. Set Point Adjustment Range: 55°F to 95°F.
4. Calibration Adjustments: None required.
5. Installation: Up to one hundred (100) ft. from controller.
6. Auxiliary Communications Port: As required.
7. Set Point Adjustment Dial: As required.
8. Occupancy Override Switch: As required.
9. Terminal Jack: As required.

B. Set Point Modes: Provide the following set point modes:

1. Independent Heating, Cooling.
2. Night Setback-Heating.
3. Night Setback-Cooling.

C. Auxiliary Communication Port: Each room temperature sensor shall include a terminal jack integral to the sensor assembly. The terminal jack shall be used to connect a portable operator's terminal to control and monitor all hardware and software points associated with the controller. RS-232 communications port shall allow the operator to query and modify operating parameters of the local room terminal unit from the portable operator's terminal.

D. Set Point Adjustment Dial: The set point adjustment dial shall allow for modification of the temperature by the building operators. Set point adjustment may be locked out, overridden, or limited as to time or temperature through software by an authorized operator at any central workstation, Building Controller, room sensor two-line display, or via the portable operator's terminal.

E. Override Switch: An override switch shall initiate override of the night setback mode to normal (day) operation when activated by the occupant and enabled by building operators. The override shall be limited to two (2) hours (adjustable.) The override function may be locked out, overridden, or limited through software by an authorized operator at the operator interface, Building Controller, room sensor two-line display or via the portable operator's terminal.

F. Room Temperature Sensors and Monitors: The following temperature sensors for space control and/or space monitoring where indicated on the drawings and as required for proper control for the project:

1. Room Temperature Control Sensor: Room sensor shall come with a wall plate suitable for surface mounting in the room. The local setpoint adjustment shall be

capable of being locked out by the BAS. The sensors shall be wired to the TEC by a cable which transmits the temperature signal to BAS.

2. Duct Mounted Space Temperature Control: For duct mounted space temperature control provide a surface mounted duct thermistor for the space TRU TEC. Thermistor shall be 10,000 Ohm with a set point adjustment range of 55ºF to 95ºF and be accurate to within ± 5ºF at mid range. The sensors shall be suitable for mounting on either a round or rectangular ductwork with self drilling screws and a gasket. The sensors shall be wired to the TEC by a cable which transmits the temperature signal to BAS. Mount the thermistor where indicated on the drawings in the exhaust duct serving room.
3. Duct Mounted Supply and Exhaust Air Temperature Monitor: For each supply and exhaust terminal unit serving a space, provide a duct mounted temperature sensor to monitor the supply and exhaust air temperature. The sensors shall provide an input for temperature monitoring range of 32ºF to 122ºF and be accurate to within ± 5ºF at mid range. The sensors shall be suitable for mounting on either a round or rectangular ductwork with self drilling screws and a gasket. The sensors shall be wired to the TEC by a cable which transmits the temperature signal to BAS.

## 2.6 FIELD DEVICES

A. Local Control Panels:

1. Controls, relays and switches for equipment located within the mechanical equipment rooms shall be mounted on enclosed control panels with hinge lock type door mounted adjacent to the system controlled.
2. Details of each panel shall be submitted for review prior to fabrication. Locations of each panel shall be convenient for adjustment and service. Manual switches shall be flush mounted on the hinged door.
3. Electrical devices within the panels shall be factory prewired to a numbered terminal strip. Wiring within the panel shall be in accordance with NEMA and UL Standards.
4. Space Temperature Monitor: In the recycling center in the north building and in the switch gear rooms of both substations provide a surface mounted temperature sensor to monitor the space temperature. The sensor shall provide an input for temperature monitoring range of 32°F to 122°F and be accurate to within ± 3°F at mid-range. The sensors shall be mounted on the wall adjacent to the local control unit. The sensor shall be wired to the nearest TEC by a cable which transmits the temperature signal to BAS along with an alarm for low temperature/high temperature.

B. Temperature Sensors:

1. Linear precision resistance elements or thermistors and resistance averaging elements shall be provided for temperature sensing. Their range shall be applicable to their installation.

2. Sensor shall have minimum accuracy of±0.5°F at 70°F.

C. Humidity Sensors:

1. Sensors shall have minimum accuracy of±3% RH over a range from 20-95% RH including hysteresis, linearity and repeatability.
2. Sensors shall be manufactured by Rotronic (F2 Series),, Contractor Instruments (Model 981/982-219), General Eastern (Model MRH-3-X), or equal.

D. Fan Status:

1. HVAC Fans: Verification of air flow for HVAC fans, which are wired from an electrical motor control center, shall be by a current sensor device unless indicated otherwise on the point schedule. Motor Start/Stop relay module shall provide either momentary or maintained switching action as appropriate for the motor being started. Relays shall be plugged in, interchangeable, mounted on a circuit board and wired to numbered terminal strips.

2. Terminal Unit Fans: Verification of air flow for fans, which are part of terminal heating and cooling units such as fan coil units, fan powered boxes, unit heaters, cabinet heaters, shall be by a current sensing device unless indicated otherwise on the point schedule.

E. Insertion Turbine Flow Meters:

1. The CCMS and UMS shall monitor and record output signal from insertion turbine flow meters where indicated on the contract documents.
2. Insertion turbine flow meter providing a pulse or 4-20ma signal linear to flow. Turbine meter shall high-resolution frequency output for connection to a BAS system and a local display module. Flow meter hall be certified to be wet calibrated with NIST traceable instrumentation and practices.
3. Physical Characteristics:

    a. Pipe Size: 2-1/2 inches through 72 inches nominal
    b. b. Pressure drop: less than 1psi at 20fps
    c. Supply Voltage: 24 VAC/DC 30ma
    d. Liquid Temperature Range

4. Standard: continuous 180ºF, 200ºF peak
5. High Temp: continuous 280ºF, 300ºF peak

    a. Operating Pressure: 400 PSI max.

6. Provide direct insertion flow meter with hot tap and valve accessory for serviceability. Flow meter shall be provided with local display and 4-20ma output to BAS system.

7. Provide dual turbine flow meters where required for bi-direction or extremely low flow sensing is required.
8. Flow meter shall be Onicon Incorporated or approved equal.

F. Control Valves:

1. Electronic Valves shall be quiet in operation and fail-safe in either normally open or normally closed position in the event of control air failure. Valves shall be capable of operating in sequence when required by the sequence of operation. Control valves shall be suitable for the pressure conditions and shall close against the differential pressure involved. Valve operators shall be of the molded synthetic rubber diaphragm type.
2. Electronic Automatic valves shall be fully proportioning with packing glands designated for hot or chilled water service. Valve bodies shall be designated for 150 psig service and shall have bronze trim and throttling plug inner valves for modulating control. Valves shall be normally open or closed as required and each shall be sized for the allowable pressure drop.
3. Two-way valves shall have external spring adjustment with a self-sealing V-ring packing arranged to tighten the seal as the water pressure increases so that no manual adjustment is necessary.
4. Three-way valves shall be of the three-way mixing type designed for 100% tight shut-off and shall have full throttling plugs, renewable composition discs and seat rings.
5. All other heating coil valves shall be either normally open or closed as specified. The interiors of all such valves shall be designed for 100% tight shut-off against the operating pressure.
6. Valves sequenced with other valves, or control devices, shall be equipped with pilot positioners or panel mounted positive positioning relays to insure proper control sequencing.
7. See Division 26, Specification Section “Valves for HVAC Piping Systems” for high performance Butterfly Valves.
8. Provide pressure gauges on main air, branch air and pilot positioner output to each valve actuator.

## PART 3 – EXECUTION

### 3.1 GENERAL REQUIREMENTS

A. The sequences listed hereinafter describe the general intent of the automatic temperature control systems. Provide all devices, equipment, and wiring as required to perform the sequences described herein.

B. Unless otherwise noted, size all automatic control valves for a maximum of ten (10) foot water pressure drop at the maximum design flow rate.

C. See plans for location of all room thermostats, control panels, dampers, valves, and equipment; where such devices are not indicated, however required by the sequences, they shall be provided and located in the field as directed by the A/E and UMB.

D. Current Sensor: All motors serving HVAC fans and pumps shall be provided with a current sensor for "on/off" status to the BAS.

E. Terminal Unit Fan Status: All fans serving fan coil units, cabinet heaters, and unit heaters shall be provided with current sensors for "on/off" status to the BAS.

F. All temperature, pressure, air flow, water flow and time set points shall be fully adjustable from the Central Control and Monitoring System (CCMS).

G. Provide all hardware, software, devices, equipment and wiring as required to interface with the CCMS.

H. Refer to input/output summary schedule for additional control items not described in the sequences. The input/output summary schedule list the minimum requirements, provide all required points for complete operation of the system.

I. Where indicated on the drawings, the variable frequency drives (VFD) for secondary pumps shall be soft started at minimum speed and increased to operating speed by the CCMS.

J. The control manufacturer shall prepare and submit for approval a composite control and interlock wiring diagram depicting the control system that will be provided.

K. All two (2) position valves shall be fitted with an end switch to indicate proof of opening and closure. The end switch shall be internal or external to the valve actuator.

L. After each Room Air Terminal Unit (RATU) has been field set at its design operating position, the BAS Contractor shall revise the program logic of each RATU so that future RATU calibration is scheduled during the unoccupied mode.

M. The BAS Contractor shall be responsible for ensuring that the room numbers assigned to all control components such as RATU'S, Thermostats etc. in the program logic are the actual room numbers used in the Building prior to the system being turned over to UMB.

3.2 SEQUENCE OF ORERATION

A. Refer to contract drawings for sequence of operations.

3.3 SEQUENCE OF ORERATION – SELF CONTAINED A/C UNITS

A. Water Cooled A/C Unit:

1. The Building Automation System (BAS) shall initiate occupied/unoccupied mode. BAS shall disable A/C Unit whenever unoccupied mode is initiated.
2. The unit shall be controlled by the factory furnished and installed microprocessor controls. The unit controls shall enable/disable cooling at the A/C unit by energizing the unit's compressor to maintain space temperature set point as sensed by space temperature sensor.
3. On a call for cooling if the unit compressor fails to start an alarm shall be transmitted to the BAS through the BAC NET IP BMS Card and the unit shall be de-energized.
4. On a call for cooling if the unit compressor starts but the unit fan fails to start an alarm shall be transmitted to the BAS through the BAC NET IP BMS Card and the unit shall be de-energized.
5. When water cooled units and/or fan coil units have auxiliary drain pans provide a moisture sensor connected to the BAS. When moisture is detected, the sensor shall send an alarm to the BAS and de-energize the unit.
6. Provide BAC NET IP BMS Communication Software to interface with the water cooled A/C unit controls.
7. The following points are included with the A/C Unit microprocessor controller. BAS shall provide BAC NET IP BMS communication software to allow for BAS monitoring. Points 'a' through 'm' and 'p' and 'q' shall be alarmed and trended by the BAS:

    a. Unit on/off —Digital Output
    b. Compressor running Module1 —Digital Output
    c. Fan running Module1 —Digital Output
    d. Compressor low pressure alarm Module1 —Digital Input
    e. Compressor high pressure alarm Module1 —Digital Input
    f. Air flow alarm Module1 —Digital Input
    g. Water detector alarm Module1 (condensate pan) —Digital Input
    h. Room temperature to high alarm —Digital Input
    i. Room temperature to low alarm —Digital Input
    j. Supply temperature to high alarm —Digital Input
    k. Supply temperature to low alarm —Digital Input
    l. Water temperature to high alarm —Digital Input
    m. Water temperature to low alarm —Digital Input
    n. Set point temperature —Analog Input
    o. Set point supply air temperature —Analog Input
    p. Actual return air temperature —Analog Input
    q. Supply air temperature —Analog Input

8. For systems requiring Humidity Control include the additional points indicated below. BAS shall provide BAC IP BMS communication software to allow for BAS monitoring. Points 'a' through 'e' shall be alarmed and trended by the BAS:

a. Humidity Sensor
b. Humidifier Active
c. Humidifier Failure Alarm
d. Room Humidity to High
e. Room Humidity to Low

9. For systems requiring auxiliary drain pans the following point shall be alarmed through the BAS:

a. Auxiliary Drain Pan Water Detector Alarm — Digital Input

## 3.4 SEQUENCE OF ORERATION – EXHAUST FANS

A. Exhaust Fan Control:

1. The CCMS shall energize exhaust fan. The exhaust fan shall be energized after the fan's isolation damper end switch has been proven the damper has opened.
2. The exhaust fan status shall be as determined by a current transducer. If the lead fan fails to energize its isolation damper shall close and a current transducer shall transmit an alarm signal the CCMS. The CCMS shall signal the lag fan isolation damper to open and after the damper has opened the lag fan shall be energized to run continuously.

## 3.5 SYSTEM INPUT/OUTPUT SCHEDULE (POINT LIST)

A. For points not listed below and for software association, see sequence of operation. Points shall be able to integrate to trends and totalizations, as applicable. Additional points not specifically called for herein but required to perform the sequences as specified shall be provided at no additional cost to the Owner.

B. Description – Input/Output Point Summary:

1. Server Rooms:

a. Analog Inputs - Measured:
1) Space Temperature
2) Compressor status
3) RH

## 3.6 EMERGENCY POWER

A. BAS Emergency Power Requirements:

1. Connect the following BAS equipment to the building emergency power system as indicated on the contract drawings:

a. Building Level Network by UPS.
b. Floor Level Control Network and ATU, FHET Power.
c. Duplex Air Compressors, emergency power only.
d. Refrigerated Air Dryers, emergency power only.
e. UPS Devices.

2. All tie-ins to the emergency power system will be accomplished through a non-switching UPS with "micro pods" to allow for servicing the UPS without interrupting the downstream components
3. BAS contractor shall coordinate the power requirements for this equipment with the electrical contractor.

## 3.7 PROJECT MANAGEMENT

A. The Contractor shall designate a project manager for the Building Automation System who will be responsible for the following:

1. Construct and maintain BAS project schedule.
2. On-site coordination of BAS requirements with all applicable trades and subcontractors.
3. Authorized to accept and execute orders or instructions for the BAS from the University's Representative.
4. Attend project meetings as necessary to avoid conflicts and delays.
5. Make necessary field decisions relating to this scope of work.

## 3.8 NUMERING/NAMING CONVENTIONS

A. Coordinate with the University's Representative to determine the University's preference for naming conventions, etc. before entering the data in the system.

## 3.9 PROGRAMING

A. Programming modifications shall also include the occupied and unoccupied modes of control for each terminal unit and any modifications to the program graphics for the BAS.

## 3.10 TESTING AND ADJUSTMENT

A. Furnish labor, material, instruments, supplies and services and bear costs for the accomplishment of the tests herein specified. Correct defects appearing under test, and repeat the tests until no defects are disclosed; leave the equipment clean and ready for use.

B. Perform tests other than herein specified which may be required by the State Building

Code, Fire Code, or Underwriter's Laboratory to whose requirements this work is to conform.

C. Furnish necessary testing apparatus, make temporary connections and perform testing operations required, at no additional cost to the University.

D. Tests performed shall not relieve the Contractor of his responsibility for leaks which may develop after the tests are made.

E. Upon completion of the project:

1. Completely adjust, ready for use, thermostats, controllers, DDC panels, transducers, valves, damper operators, relays, etc., provided under this Section.
2. Load and debug software and related data base provided for under this Contract.

3.11 START UP AND COMMISSIONING

A. Start Up: Comply with the following:
1. When installation of the system is complete, calibrate equipment and verify transmission media operation before the system is placed on-line. Testing, calibrating, adjusting and final field tests shall be completed by the installer. Verify that systems are operable from local controls in the specified failure mode upon panel failure or loss of power.

2. Provide any recommendation for system modification in writing to University. Do not make any system modification, including operating parameters and control settings, without prior approval of University's Representative.

B. Commissioning: See Division 26, Specification Section "Commissioning HVAC Systems" for requirements. Schedule a time and date with the UMB Commissioning representative through the UMB-PM.

END OF SECTION 230900

# SECTION 230902 – CONTROL VALVES AND DAMPERS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 26.

### 1.2 GENERAL

A. No devices containing mercury will be allowed under this Specification.

### 1.3 SUBMITTALS

A. Product data sheets shall include construction materials and assembly methods, maximum design parameters (temperature, pressure, velocity, etc.), and performance data for full range of actuator stroke. Product data sheets shall include charts, graphics or similar items used in making selections, including damper to duct area ratio and free area ratio. Damper product data sheets shall indicate certified leakage rates for given pressure differentials.

B. Submit valve schedules with shop drawings, indicating unique tag numbers for each device, equipment item or system served, device model numbers, sizes, shut-off head required, actuator air pressure or force required to meet shut-off head, torque requirements for rotary valves, flow coefficients (Cv) for 10% and 100% valve stem travel, actual flow requirements based on equipment shop drawings, calculation of actual pressure drops, actuator model number, actuator torque capacities and pilot positioner locations.

C. Valve and damper Shop Drawing submittals will not be processed unless supporting data and sizing calculations are included.

D. Submit damper schedules with Shop Drawings, indicating unique tag numbers for each device, equipment or system served, device model numbers, duct sizes, damper sizes, flow rates, pressure differentials, calculation of actual damper pressure drops, approach velocities, leakage rates, torque requirements, actuator model number, actuator torque capacities and pilot positioner locations.

E. Select dampers to meet their intended service with respect to maximum approach velocities and maximum pressure differential. Damper materials shall match duct construction materials of systems in which they are installed (galvanized steel, aluminum, Type 304 or 316 stainless steel, etc.).

F. Aluminum dampers may be used in galvanized steel ductwork.

1.4 VALVE SELECTION AND SIZING

A. General:
   1. Select control valves to meet their intended service without cavitation. Provide cavitation calculations for modulating globe control valves over 250°F and all modulating butterfly valves over 60°F.
   2. Select control valves and actuators for 100% shut-off against system maximum differential pressure.
   3. Valve body ratings indicated in Part 2 are minimum required. Valve body, trim and packing selected shall be designed to withstand maximum pressure and temperature encountered in system.
   4. Submit engineering calculations for sizing modulating control valves unless valves are scheduled. Control valves serving terminal devices may be sized based on flow ranges for each pump system.
   5. Shut off and two (2) position valves shall be full pipe size.
   6. Calculations for sizing modulating valves shall be based on actual characteristics of equipment and system in which valves are installed. Valve calculations shall include information such as pump head or available pressure.
   7. Control Contractor is responsible for obtaining adequate system information necessary for sizing.

B. Minimum pressure and temperature rating of piping systems (complete system of pipe, fittings, joints, etc.) shall be as follows. Where more stringent pressure and temperature ratings are specified under individual product specifications, the more stringent ratings shall be provided.
   1. Chilled Water: 200 psig at 100°F

C. Instrumentation Valves:
   1. Unless otherwise noted, instrumentation shut-off valves for isolation of gauges, switches, transmitters, etc., shall be as specified in Division 26, Specification Section “Valves for HVAC Piping System”.

D. Water Valves:
   1. Unless otherwise indicated, select modulating control valves to provide 3 psi to 5 psi pressure drop at design flow rate.
   2. Design criteria for sizing modulating valves shall be based on two (2) port, equal percentage valves unless otherwise specified. Select heating and cooling coil control valves of major equipment including air handling units for minimum of 30% to 50% of equipment sub-circuit pressure drop, but not more than maximum available pump head allowing minimum 2 psi drop for balancing valve.
   3. Select control valves based upon pressure drop calculations and (Cv) values at 90% stroke.

4. Size three (3) way mixing or diverting valves not directly associated with pump sub-circuit for 3 psi to 5 psi pressure drop.
5. Sub-circuit is defined as branch supply and return piping to terminal device, including valve, coil, control valve, and balancing valve.

1.5 DAMPER SELECTION AND SIZING

A. Submit engineering calculations for sizing modulating control dampers including outside, return, and relief air dampers of air handling units unless dampers are scheduled.

B. Calculations for sizing dampers shall be based on actual characteristics of ductwork system being installed. Opposed blade dampers shall be sized for minimum of 10% of duct system pressure drop. Parallel blade dampers shall be sized for minimum of 30% of duct system pressure drop. Duct section is defined as ductwork containing flow control damper starting with inlet or branch tee and ending with outlet or branch tee. Calculate actual duct pressure drops for each duct section containing modulating damper using latest version of ASHRAE Handbook of Fundamentals. If control systems fixes pressure drop, use those pressure set points. Use balance damper to provide additional pressure drop as required for obtaining linear damper response.

C. Control Contractor is responsible for obtaining adequate system information necessary for sizing.

D. Two (2) position dampers to be sized as close as possible to duct size, but in no case is damper size to be less than duct area.

E. Submit leakage and flow characteristic data for control dampers along with shop drawings. Leakage ratings shall be based on AMCA Standard 500 and dampers shall bear AMCA Air Leakage Seals.

1.6 WARRANTY/GUARENTEE

A. See Division 26, Specification Section “Basic Mechanical Requirements – HVAC” for warranty and guarantee requirements.

**PART 2 - PRODUCTS**

2.1 GENERAL PRODUCT REQUIREMENTS

A. Equipment Design and Selection: All BAS valves, dampers and accessories shall be designed and selected, for the intended use, in accordance with the the requirements of this specification.

B. Acceptable Manufacturers: Acceptable manufacturers of valves, dampers and accessories shall be as follows:

1. High Performance Butterfly Valves: See Division 26, Specification Section "Valves of HVAC Piping Systems" for acceptable valves.

2. Solenoid Valves: Subject to compliance with requirements, provide solenoid valves by one (1) of the following:
   a. Siemens Building Technologies.
   b. Johnson Controls.
   c. Honeywell.

3. Control Dampers: Subject to compliance with requirements, provide control dampers by one (1) of the following:
   a. Ruskin.
   b. Air Balance.
   c. Johnson Controls.
   d. Honeywell.
   e. Greenheck.

4. Actuators for Valves and Dampers: Subject to compliance with requirements, provide acturators by one (1) of the following:
   a. Siemens Building Technologies.
   b. Johnson Controls.
   c. Honeywell.

## 2.2 CONTROL VALVES

A. General:
   1. If control valves are not scheduled, refer to Part 1 of this Section for sizing criteria.
   2. Use two (2) port or three (3) port globe type control valves with equal percentage contoured throttling plugs for water applications, except as otherwise noted.
   3. Butterfly valves shall be used for water system control valves three (3) inches and larger provided that valves meet pressure and temperature requirements. Use high performance butterfly valves.

B. High Performance Butterfly Valves:
   1. Valves shall be as specified in Division 26, Specification Section "Valves for HVAC Piping Systems".
   2. Provide actuator and positioner. Provide limit switches as required and as indicated.
   3. Valves and actuators shall be manufactured by valve manufacturer. Valve assembly including actuator, positioner and limit switches if used shall be assembled by valve manufacturer.

C. Solenoid Valves:

1. Valves shall be brass or bronze body. Select valves to match required temperatures and pressures, and to have materials that are compatible with intended working fluids.
2. Line voltage actuators shall be Class "H" (high temperature), listed by UL or CSA.

## 2.3 CONTROL DAMPERS

A. General:
1. If control damper sizes are not shown or scheduled, refer to Part 1 of this Section for sizing criteria.
2. Unless otherwise indicated, modulating control dampers shall be opposed blade or parallel blade type and two (2) position (open/close) dampers shall be parallel blade type.
3. Blade linkage hardware shall have corrosion-resistant finish and be readily accessible for maintenance.
4. AMCA Leakage Classification of Control Dampers

| Class | Static Pressure (Inches Water Column) | | | |
|---|---|---|---|---|
| | 1 | 4 | 8 | 12 |
| | Leakage Rate cfm/ft$^2$ | | | |
| IA | 3 | N/A | N/A | N/A |
| I | 4 | 8 | 11 | 14 |
| II | 10 | 20 | 28 | 35 |
| III | 40 | 80 | 112 | 140 |

B. Standard Modulating and Two (2) Position Dampers:
1. Manufacturers and acceptable model numbers:
   a. Johnson Controls VD-1330 (Double Piece)
   b. Honeywell D2
   c. Ruskin CD50/CD60
   d. Air Balance AC-525/526
   e. Greenheck VCD-43/VDC-60
2. Damper frames shall be a minimum of 16 gauge galvanized steel or 14 gauge extruded aluminum. Blades shall be a minimum of 16 gauge galvanized steel or 14 gauge aluminum. Blades shall have maximum blade width of eight (8) inches with steel trunnions mounted in bronze sleeve, nylon or ball bearings.
3. Furnish dampers with blade seals and stainless steel side seals. Dampers and seals shall be suitable for maximum system temperature, pressure differential and approach velocity, but not less than temperature range of -40° to 200°F, pressure

differential of six (6) inches WC, and approach velocity of four thousand (4,000) fpm based on four (4) feet damper section width.

4. Leakage rate shall meet AMCA Leakage Class IA or I.
5. Testing and ratings shall be per AMCA Standard 500-D.

## 2.4 DAMPER AND VALVE ACTUATORS

C. Analog Electronic:
   1. Actuators shall be electric motor/gear drives that respond proportionally to analog voltage or current input, or digital floating control signals.
      a. Floating control actuators shall only be used for terminal hot water or chilled water control.
      b. Analog control actuators shall be used for all other modulating applications.
   2. Stroke time for major equipment shall be ninety (90) seconds or less for 90° rotation. Stroke time for terminal equipment shall be compatible with associated local controller, but no more than six (6) minutes.
   3. Provide spring return feature for fail open or closed positions, as required by control sequence, for critical applications such as outside, return, or exhaust dampers, heating and cooling coils on major air handling units, humidifiers, heat exchangers, flow control for major equipment items such as chillers, cooling towers, boilers, etc. Fail-last-position actuators do not have spring return feature.
   4. Provide position feedback potentiometers connected to controller for closed loop control on major equipment analog control loops.

D. Discrete Two (2) Position Electric:
   1. Actuators shall be electric motor/gear drives for two-position control. Stroke time shall be ninety (90) seconds or less for 90° rotation.
   2. Provide spring return feature for fail open or closed positions as required by control sequence. Fail-last-position actuators do not have spring return feature.

E. Discrete Two (2) Position Heavy-Duty Electric:
   1. Actuators shall be hydraulic or electric motor/gear drives for two-position control. Stroke time shall be ninety (90) seconds or less for 90° rotation.
   2. Provide spring return feature for fail open or closed positions as required by control sequence. Fail-last-position actuators do not have spring return feature.
   3. Unless otherwise indicated, actuator power shall be 120 VAC, 60 Hz, 1 Ph.

## PART 3 - EXECUTION

3.1 CONTROL VALVES

A. Furnish control valves as shown on drawings and/or as required to perform control sequences specified.

B. Control valves furnished by Control Contractor shall be installed by Mechanical Contractor under coordinating control and supervision of Control Contractor.

C. Increaser and decreaser fittings required to facilitate valve installations shall be provided by Mechanical Contractor.

3.2 CONTROL DAMPERS

A. Furnish control dampers as shown on drawings and/or as required to perform control sequences specified, except those furnished with other equipment.

B. Control dampers furnished by Control Contractor shall be installed by Mechanical Contractor under coordinating control and supervision of Control Contractor.

C. Blank-off plates or transitions required to facilitate dampers shall be provided by Mechanical Contractor.

3.3 ACTUATORS AND PILOT POSITIONERS

A. Provide actuator for each automatic damper or valve with sufficient capacity to operate damper or valve under all conditions. Select actuators to provide tight shut-off against maximum system temperatures and pressure encountered. Each actuator shall be full-modulating or two-position type as required or specified, and shall be provided with spring-return for fail open or fail closed position for fire, freeze, moisture, occupant safety, equipment protection, heating or cooling system protection on power interruption as indicated and/or as required.

B. Valve and damper operating speeds shall be selected or adjusted so that actuators will remain in step with controllers without hunting, regardless of load variations. Actuators acting in sequence with other actuators shall have adjustment of control sequence as required by operating characteristics of system.

C. Provide speed control valves for “On/Off” actuators for adjustment of actuator speed to prevent water hammer or excessive stress on large valves and dampers.

D. Provide proper linkage and brackets for mounting and attaching actuators to devices. Design mounting and/or support to provide no more than 5% hysteresis in either direction (actual movement of valve stem or damper shaft versus ideal movement) due to deflection of actuator mounting.

E. Multiple damper sections shall be connected together via jackshaft or other coupling device, not by internal pinned connections at the blade shafts of individual damper sections. Where multiple damper sections are connected together via jackshaft or other coupling device, damper actuators shall be mounted directly to the jackshaft or other coupling device for operating damper sections. For instances where the damper actuator cannot be mounted to the jackshaft or other coupling device, damper actuators shall be provided for each damper section.

F. Calibrate position feedback potentiometers, where specified, with range and gain factors as required for proper operation per manufacturer's recommendations.

END OF SECTION 230902

# SECTION 230992 – BUILDING AUTOMATION SYSTEM – ENERGY FLOW METERS

## PART 1 – GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this section and all the other sections of Division 23.

### 1.2 SUMMARY

A. This section includes the requirements for energy meters that measure and record energy and fluid flow from HVAC Hydronic Water Systems and transmit the data to the BAS using the following meter types:

1. Inline energy meters.
2. Insertion energy meters.
3. Ultrasonic energy meters.

### 1.3 ACTION SUBMITTALS

A. Product Data: For each specified product, include manufacturers cut sheets, dimensional data, performance data, installation instructions, specified options, and warranty information.

### 1.4 INFORMATIONAL SUBMITTAL

A. Manufacturer's Installation Instructions: Indicate manufacturer's installation instructions for manufactured components.

B. Product Certificates: For each type of meter and gage, from manufacturer.

### 1.5 CLOSEOUT SUBMITTAL

A. Operation and Maintenance Data: Include a copy of each approved submittal along with any applicable maintenance data in the project operation and maintenance manual.

B. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in University's name and registered with manufacturer.

### 1.6 ELECTRICAL WIRING (BAS)

A. Electric wiring, wiring connections and interlock wiring required for the installation of energy flow meters, as herein specified, shall be provided as specified in this section,

unless specifically shown on the Electrical drawings or called for in the Electrical specifications. Electrical power requirements, including junction boxes, for all BAS energy meters shall be provided by the electrical contractor as indicated on the electrical drawing and in the electrical specifications. Extension of power wiring from junction boxes to the energy meters shall be provided by the BAS contractor.

1.7 WARRANTY/GUARANTEE

A. See Division 23 Specification Section "Basic Mechanical Requirements – HVAC" for warranty and guarantee requirements.

**PART 2 – PRODUCTS**

2.1 GENERAL PRODUCT REQUIREMENTS

A. Equipment Design and Selection: Energy flow meters shall be designed and selected, for the intended use, in accordance with the requirements of this specification.

B. Acceptable Manufacturers: Acceptable manufacturers of energy meters shall be as follows:

1. Inline and Insertion Energy Meters: Subject to compliance with requirements, provide energy flow meters by one (1) of the following:
   a. Onicon.
   b. Krone.
   c. Foxboro.

2. Ultrasonic Energy Meters: Subject to compliance with requirements, provide energy flow meters by one (1) of the following:
   a. Badger Meters or approved equal.

2.2 HVAC ENERGY METERS AND FLOW METERS

A. General: Provide energy and flow meters (EFM) where indicated on the drawings, details, and diagrams. Each EFM shall include one (1) BTU energy measurement meter, and one (1) flow measurement meter. Each energy measurement meter shall be capable of communicating with the campus energy system through MODBUS TCP/IP protocol. Each flow measurement meter shall be capable of communicating with the building automation system (BAS) through MODBUS TCP/IP protocol or a Siemens P1 FNL protocol. Basis of design is Onicon equipment as specified hereinafter.

B. Energy Measurement Meters: Provide Energy Measurement Meters for either Ethernet Applications or Non Ethernet Applications as directed by UMB and/or as follows:

1. Energy Measurement Meter – Ethernet & Non Ethernet Applications: Provide an Onicon System 10 BTU Meter complete with two (2) state of the art temperature meters, two (2) thermo wells and all required installation hardware. All equipment shall be provided by the same manufacturer and include a certificate of calibration for the energy meters. The energy meter shall include the following features:

   a. Information Data: The energy measurement meter shall provide the following data both locally and remotely, from each system, via direct Ethernet communications capability as follows:

      1) Chilled Water Systems:

         a) Total Energy: In Btu, kWh, and ton-hours.
         b) Energy Rate/Demand: Btu/hr, kW, and tons.
         c) Total Volume: In Gallons (Gal).
         d) Volume Flow Rate: In Gallons per Minute (GPM).
         e) Supply Temperature: In ºF.
         f) Return Temperature: In ºF.
         g) All readings must have a minimum accuracy of +/- 0.4%.

   b. Operator Interface/Display: Menu driven display and membrane keypad make viewing data easy and simplify field re-programming, when necessary. Alphanumeric LCD displays total energy, total flow, energy rate, flow rate, supply temperature and return temperature. Alpha: sixteen (16) character, 0.2 inches high; Numeric: Six (6) digits, 0.4 inch high.
   c. Memory - Non-volatile: EEPROM memory retains all program parameters and totalized values in the event of power loss. Minimum memory size shall be adequate to store all metered quantities above at fifteen (15) minute intervals for at least twenty five (25) hours.
   d. Programming: Factory programmed for specific application and field programmable via front panel interface.
   e. Accuracy: Differential temperature accuracy ±0.15ºF over calibrated range computing nonlinearity within ±0.05%. Flow Meter accuracy to within ±0.5% of rate at the calibrated typical flow rate and within ±2% of rate over an extended 50:1 turndown range (0.4 - 20 ft/s).
   f. Control Power: Contract electrical contractor to provide 120VAC, 20amp electrical branch circuit to Btu meter via #12 awg stranded copper and 3/4 inch EMT conduit with compression fittings. Btu meter to include internal 120VAC, minimum 200mA power supply with optional 24 VDC at 200 mA to electronics and flow meter. Provide all necessary field wiring for flow meter and other ancillary electronics to be sub-fed from Btu meter power supply.
   g. Enclosure: Provide manufacturer's optional NEMA 4 enclosure to protect internal circuit boards from exposure to dirt, oil and dripping water.
   h. Temperature Meters: Solid state meters are custom calibrated using

N.I.S.T. traceable temperature standards. Current based signal (mA) is unaffected by wire length. Custom calibrated and matched to accuracy better than ±0.15ºF from 32ºF to 200ºF.

i. Temperature Ranges:

1) Liquid Temperature Range: 32ºF to 200ºF.
2) Ambient Temperature Range: 40ºF to 120ºF.

j. Temperature Thermo Wells: For piping up through four (4) inch provide one half (1/2) inch NPT brass thermo wells. For steel piping and/or fiberglass reinforced (FR) piping, six (6) inch and larger provide 1/2 inch NPT stainless steel thermo wells.

k. Communications/Remote Interfacing: Provide all necessary components for connecting the Energy Measurement System directly to the existing Ethernet network and for remote interrogation of the above metered quantities via MODBUS TCP/IP protocol. The system will be assigned a network IP address and will be remotely interrogated by the local building automation system as well as other systems in the future. The system must be ready for remote interrogation by multiple, separate remote systems via MODBUS TCP/IP.

l. Commissioning: Coordinate with the Flow Meter manufacturer's sales representative and confirm meter installation is satisfactory and coordinate with the building automation vendor for performing meter startup, programming and integration with the BAS.

C. Energy Measurement Meter – Non-Ethernet Application: Provide an Onicon System 10 BTU Meter as specified hereinbefore, and an Onicon Display Module, Model D-100. All equipment shall be provided by the same manufacturer and include a certificate of calibration for the energy system. The display module shall include the following features:

1. Information Data: The display module shall transmit data from the system 10 meter and/or the flow meter to the BAS both locally and remotely, from each system, via a Siemens P-1–FLN serial card.
2. Display: Alphanumeric LCD display of liquid or steam flow rate and total data. Alpha: Sixteen (16) character, 0.2 inches high; Numeric: Six (6) digits, 0.4 inch high.
3. Memory - Non-volatile: EEPROM memory retains all program parameters and totalized values in the event of power loss. Minimum memory size shall be adequate to store all metered quantities above at fifteen (15) minute intervals for at least twenty five (25) hours.
4. Programming: Factory programmed for specific application and field programmable via front panel interface.
5. Accuracy: Analog inputs and outputs accurate to within 0.1% of full scale.

6. Control Power: Contract electrical contractor to provide 120VAC, 20amp electrical branch circuit to the display module via #12 awg stranded copper and 3/4 inch EMT conduit with compression fittings. Display module to include internal 120VAC, minimum 200mA power supply with optional 24 VDC at 200 mA to electronics and meters. Provide all necessary field wiring for flow meter and other ancillary electronics to be sub-fed from the display module.
7. Enclosure: Provide manufacturer's optional NEMA 4 enclosure to protect internal circuit boards from exposure to dirt, oil and dripping water.
8. Communications/Remote Interfacing: Provide all necessary components for connecting the D – 100 display module directly to the existing BAS and for remote interrogation of the above metered quantities via Siemens P1-FLN protocol. The system will be assigned a network IP address and will be remotely interrogated by the local building automation system as well as other systems in the future.
9. Commissioning: Coordinate with the Flow Meter manufacturer's sales representative and confirm meter installation is satisfactory and coordinate with the building automation vendor for performing meter startup, programming and integration with the BAS.

D. HVAC System Flow Measurement Meter: Flow Measurement Meters shall be as indicated below:

1. Inline Electromagnetic Flow Meter: Provide an Onicon F-3100 Series Inline Electromagnetic Flow Meter complete with backlit graphic display. All equipment be provided by the same manufacturer and include a certificate of calibration for the energy system. The flow meter shall include the following features:

   a. Information Data: The flow measurement meter shall provide the following information both locally and remotely via direct MODBUS TCP/IP Ethernet communication capability:
   b. HVAC Water Systems:

      1) Total Volume: In Gallons (Gal)
      2) Volume Flow Rate: In Gallons per Minute (GPM)
      3) All readings must have a minimum accuracy of +/- 0.4%.
      4) Accuracy: Accurate shall be within ±0.5% of rate at the calibrated typical flow rate and within ±2% of rate over an extended 50:1 turndown range (0.4 - 20 ft/s).
      5) Flow Type: Flow type shall be single direction unless otherwise directed by UM.

   c. Connection Type: Provide ANSI Class 150 Flanges. Wafers are not approved. Provide all necessary mating flanges and any required reducer/expanders.

d. Flow Tube: The flow tube shall be epoxy coated steel; the sensing electrodes shall be 316SS; the liner shall be polypropylene or ebonite for low temperature service, PFTE for hot water service (302ºF maximum).
e. Programming: Each flow meter shall be factory programmed for its specific application, and shall be re-programmable using the integral keypad on the converter (no special interface device or computer required).
f. Transducer/Meter Control Power: Control power shall be 24VDC from the BTU Meter.
g. Commissioning: Coordinate with the flow meter manufacturer's sales representative and confirm meter installation is satisfactory and coordinate with the building automation vendor for performing meter startup, programming and integration with the BAS.

2. Insertion Electromagnetic Flow Measurement Meter: Provide an Onicon F-3500 Series Insertion Electromagnetic Flow Meter complete with all installation hardware. All equipment be provided by the same manufacturer and include a certificate of calibration for the flow meter. The flow meter shall include the following features:

a. Information Data: The flow measurement meter shall provide the following information both locally and remotely via direct MODBUS TCP/IP Ethernet communication capability:

1) HVAC Water Systems:

a) Total Volume: In Gallons (Gal).
b) Volume Flow Rate: In Gallons per Minute (GPM).
c) All readings must have a minimum accuracy of +/- 0.4%.

2) Material:

a) Wetted Material: Stainless steel, type 316.
b) Sensor Head: Polypropylene

3) Accuracy: Accurate to within +/-1.0% of reading from two (2) to twenty (20) feet/second (ft/sec) and+/-0,02ft/sec below two (2) ft/sec.

4) Flow Type: Flow type shall be single direction.
5) Temperature Range:

a) Liquid: 15ºF to 250ºF.
b) Ambient: -5ºF to 150ºF.

6) Output Signals:

a) Analog: Selectable 4-20 mA, 0-10V or 0-5V.
b) Frequency: 0-15 volt peak pulse, 0-500Hz.
c) Scalable Pulse: 0.5, 1, 2, or 6 second duration.

7) Electrical Connection: Ten (10) feet of PVC jacketed cable with one half (1/2) NPT conduit connection.
8) Connection Type: Provide a standard installation kit for steel pipe and or FR pipe, including a one (1) inch full port ball valve, close nipple, and branch outlet.

3. Insertion Turbine Flow Measurement Meter: Provide an Onicon F-1100 Series, single direction, Insertion Turbine Flow Meter and/or Onicon F-1200 Series, Bidirectional Insertion Turbine Flow Meter complete with all installation hardware. All equipment be provided by the same manufacturer and include a certificate of calibration for the energy system. The flow meter shall include the following features:

a. Information Data: The flow measurement meter shall provide the following information both locally and remotely via direct MODBUS TCP/IP Ethernet communication capability:

1) HVAC Water Systems:

a) Total Volume: In Gallons (Gal).
b) Volume Flow Rate: In Gallons per Minute (GPM).
c) All readings must have a minimum accuracy of +/- 0.4%.

2) Material:

a) Wetted Material: Stainless steel, type 316.
b) Sensor Head: Polypropylene

3) Accuracy: Accurate to within +/-1.0% of reading from two (2) to twenty (20) feet/second (ft/sec) and+/-0,02ft/sec below two (2) ft/sec.
4) Flow Type: Flow type shall be single direction and/or bidirectional.
5) Temperature Range:

a) Liquid: 15ºF to 250ºF.
b) Ambient: -5ºF to 150ºF.

6) Output Signals:

a) Analog: Selectable 4-20 mA, 0-10V or 0-5V.
b) Frequency: 0-15 volt peak pulse, 0-500Hz.
c) Scalable Pulse: 0.5, 1, 2, or 6 second duration.

7) Electrical Connection: Ten (10) feet of PVC jacketed cable with one half (1/2) NPT conduit connection.
8) Connection Type: Provide a standard installation kit for steel pipe and or FR pipe, including a one (1) inch full port ball valve, close nipple, and branch outlet.

## 2.3 ULTRASONIC ENERGY AND FLOW METERS

A. Meter Type: Provide an ultrasonic energy flow meter and accessories where indicated on the drawings and diagram. Energy flow meters shall be clamp on type flow and energy meter for liquids Dynasonics Model TFX Ultra as manufactured by Badger Meters Inc.

B. Components: Components shall include the following:

1. Transmitters and Transducers: Unit shall be comprised of two transducers for the transmission and reception of ultrasonic signals, a digital signal processor module to integrate raw measurement data and compute volumetric flow and/or energy rate and total, and an LCD display. Data can be output to a SCADA system, PLC or BAS (building automation system) using various analog, digital, serial, and/or IP outputs.

2. Temperature Sensors: Sensors used to measure temperature by correlating the resistance of the RTD element with temperature. Set consists of one to measure liquid in the inlet pipe, and one to measure the liquid in the outlet pipe.

3. Mounting Hardware: Stainless steel mounting straps and two types of acoustic coupling medium for proper mounting of the transducers in either short term or long term applications.

4. Units of Measurement: Units of measurement shall be as follows:

   a. Flow: Gallons and cubic feet.
   b. Energy: BTU, MBTU, MMBTU, Tons and kW.
   c. Rate: Seconds, minutes and hours.

5. Data Outputs: Data outputs shall be as follows:

   a. Native: 4-20ma; 12-bit resolution, internally powered, can span negative to positive flow/energy rates; test function allows simulated flow output to verify proper installation and span settings on receiving equipment.
   b. Optional Outputs: 10/100 Base-T Ethernet (ODVA™ CIP™ Compliant); Modbus TCP/IP, Ethernet/IP and BACnet®/IP protocols.

6. PC Software Utility: PC software utility shall be included to configure calibrate, backup and conduct diagnostics on the flow meter. The software shall be compatible with Windows 7 and 10 operating systems.

7. Warranty/Guarantee: See Division 23, Specification Section "HVAC General Requirements."

8. Calibration: Flow meter calibration data shall be performed by the factory prior to use. Calibrate to NIST standards to ensure between ±1% accuracy of reading for transit time.

## PART 3 – EXECUTION

### 3.1 GENERAL

A. Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of meters and gauges in the HVAC piping systems. So far as practical, install meters as indicated.

B. Accessibility: All meters shall be installed in accessible locations for maintenance.

C. Provide unions and isolation valves for each water meter. See Division 23 Specification Section "Valves for HVAC Piping Systems" for required valves.

D. Mechanical Requirements: See details on the mechanical and/or plumbing drawings for installation requirements.

E. Electrical Requirements: See Electrical drawings for power requirements.

### 3.2 INSTALLATION – HVAC ENERGY METERS AND FLOW METERS

A. Energy Measurement Meter: Installation includes the meter and two (2) temperature sensors. Install the meter in the location indicated on the drawings and/or where directed by UMB. The meter and temperature sensor locations must provide access to the devices for service.

B. Pipe System Installation: Energy and flow meters supplied by the BAS contractor shall be installed in the piping systems by the mechanical contractor. See Division 23, Specification Section "Meters and Gauges for HVAC Piping" for installation requirements.

C. BAS Interface Wiring: All BAS interface wiring to the BAS and power wiring from a local junction box shall be provided and installed by the control contractor.

D. Power Wiring: Power wiring from the electric panel to the local junction box shall be provided by the electrical contractor. All power wiring from a local junction box to the meter shall be provided and installed by the control contractor.

## 3.3 INSTALLATION – ULTRASONIC ENERGY AND FLOW METERS

A. Ultrasonic Energy Meter: Install the ultrasonic meter display unit in an accessible location sixty (60) AFF on the nearest wall. Install the remote transducers and temperature sensors on the existing chilled water piping in a location will promote a clear reading, and provides the minimum straight runs of pipe on both upstream and downstream piping sections of the transducers and temperature sensors. Additional installation requirements are as follows:

1. Transducers: Mount the transducers onto the pipe at the calculated separation distance. Where the transducers are located on the chilled water piping remove a section of pipe insulation and install the transducers per the manufacturers installation instructions. After the transducers have been secured in place caulk all around the outer edge each transducer body with a non cracking DOW 732 Silicone Sealant. When the sealant has cured insulate the piping up to and between the transducers. Connect the transducer leads to the remote meter.

2. Temperature Sensors: Mount the temperature sensors onto the supply and return pipes according to the direction provided in the instruction manual. Where the temperature sensors are located on the chilled water piping remove a section of pipe insulation and install the sensors around the pipe per the manufacturers installation instructions. Cover each sensor with insulation and extend the sensor lead through the insulation. Place a bead of caulk around the lead where it passes through the insulation jacket. Connect the sensor leads to the remote meter.

3. Provide supports for the wire leads between the meter and the transducers and sensors.

B. Installation does not require system shut down and/or cutting into any piping.

C. Follow manufacturer's recommendation upstream and downstream straight pipe diameters and transducer orientation to achieve optimum performance.

D. Enter pipe and liquid configuration information into the flow meter. The flow meter will calculate transducer separation from the data entered.

## 3.4 ELECTRICAL WIRING (BAS)

A. Furnish labor and material to install the necessary wiring to accomplish the successful and complete operation of the new automation system (DDC).

B. Furnish labor and material to install necessary relays, general purpose enclosures and appurtenances to control designated devices relative to the BAS.

C. Wiring throughout shall be concealed where possible.

D. Conduit used shall be EMT, three quarter (3/4) inch minimum size. Conduit sizes shall be large enough to permit the individual conductors to be readily installed or withdrawn without damage to the conductors or their insulation. Splicing of wires will be permitted only in junction boxes or pull boxes.

END OF SECTION 230992

# SECTION 231101 – LEAK TEST HVAC PIPE AND DUCT SYSTEMS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 23.

### 1.2 SUMMARY

A. This section includes the requirements for leak testing of the following systems:

1. Hydronic piping (all water and glycol piping systems).
2. Refrigerant piping.
3. Supply ductwork.
4. Return air ductwork.
5. Exhaust ductwork.
6. Fresh air ductwork.

### 1.3 SUBMITTALS

A. General: Submit completed certified test reports for each item in this Section according to the Conditions of the Contract and Division 01 Specification Sections.

### 1.4 QUALITY ASSURANCE

A. Testing shall be performed by the installer of system being tested in presence of the UMB Representative.

### 1.5 WARRANTY/GUARANTEE

A. See Division 23 Specification Section “Basic Mechanical Requirements – HVAC” for warranty and guarantee requirements.

## PART 2 - PRODUCTS

### 2.1 PIPE SYSTEM LEAK TEST APPARATUS

A. The contractor conducting the test shall arrange for and provide all temporary services, all test apparatus, all gages, hoses and qualified personnel necessary to conduct the required testing. All leak tests shall be witnessed by UMB’s Representative. UMB requires a minimum of seven (7) days’ notice of all test procedures. Prior to scheduling

the test with UMB the contractor conducting the test shall pretest the system or segment to ensure all joints, connections etc. are leak free.

B. Test apparatus shall include a pump of appropriate size and pressure capability for all pressurized liquid systems and an oil free air compressor or gaseous nitrogen to pressurize all gaseous piping systems to the required test pressures.

C. Pressure gauges used for the test shall be in the required range and increment of the appropriate test. Gauges used for testing shall be as follows:

1. Tests requiring a pressure of 10 pounds per square inch (psi) or less shall utilize a testing gauge having increments of 0.10 psi or less.
2. Tests requiring a pressure of greater than 10 psi but less than or equal to 100 psi shall utilize a testing gauge having increments of 1 psi or less.
3. Tests requiring a pressure of greater than 100 psi shall utilize a testing gauge having increments of 2 psi or less.

D. All gauges must be set at zero before pressure is applied to the test segment.

E. Contractor conducting the test shall utilize the "UMB Standard Pipe System Leak Test Summary Form" for each pipe test to record the test results. Where multiple tests are conducted on the same pipe section a summary report of each test (pass and failed test) shall be prepared. Each summary report shall be signed by each of the parties witnessing the test. The completed reports shall be forwarded to the Construction Manager (CM). The CM or GC shall provide a copy of the reports to UMB Project Manager.

2.2 DUCT SYSTEM LEAK APPARATUS

A. The contactor conducting the test shall arrange for and provide all temporary services, all test apparatus, all temporary seals and qualified personnel necessary to conduct the required testing. All test shall be witnessed by UMB Personnel and selected test shall be witnessed by the balancing contractor. UMB requires a minimum of seven (7) days' notice for all test procedures. Prior to scheduling the test with UMB the contractor conducting the test shall pretest the system or segment to ensure all joints, connections etc. are leak free.

B. Test apparatus shall include an airflow measuring device consisting of an orifice assembly, straightening vanes and a orifice plate mounted in a straight tube, a flow producing unit consisting of a fan and an inlet damper, and pressure indicating devices consisting of a u-tube manometer (#2) across the orifice plate, a duct test pressure u-tube manometer (#1), an inclined manometer for reading orifice differential pressures below on (1) inch water gauge and accessories necessary to connect the metering system to the test specimen. The test procedure shall be as outlined in Part 3 – Execution. A copy of the certified performance curve indicating flow versus differential pressure shall be permanently attached to the test apparatus.

C. Test apparatus shall have calibration data and certificate signifying manufacturer of the meter in conformance with the ASME Requirements for Fluid Meters.

D. Orifice Plates in the test tubes shall be steel or stainless steel. Orifice openings shall be centered in the metal tube. The plates shall be flat and have holes with square edges (90 degrees) that are free of burrs. Plates shall be perpendicular to the flow path and shall be free of leaks at points of attachment.

E. Taps for static pressure indication across orifices shall be made with one sixteenth (1/16) inch to one eighth (1/8) inch diameter holes drilled neatly in the meter tube wall. The interior of the tube shall be smooth and free of projections at the drilled holes.

F. Pressure differential sensing instruments shall be readable to 0.05 inch scale division for flow rates below ten (10) cfm or 0.5 inch wg differential. For higher flow scale divisions of 0.1 inch are appropriate. U tube manometers should not be used for readings less than one (1) inch of water.

G. Liquid for manometers shall have a specific gravity of one (1) (as water) unless the scale is calibrated to read in inches of water contingent on the use of a liquid of another specific gravity, in which case the associated gage fluid must be used.

H. The duct test pressure shall be sensed only from an opening in the duct.

I. Instruments must be adjusted to zero reading before pressure is applied.

J. Contractor conducting the test shall utilize the "UMB Standard Air Duct Leak Test Summary Form" for each duct test to record the test results of each test. Where multiple tests are conducted on the same duct section a summary report of each test (pass and failed test0 shall be prepared. Each summary report shall be signed by each of the parties witnessing the test. The completed reports shall be forwarded to the Construction Manager (CM) or the General Contractor (GC). The CM or GC shall provide a copy of the reports to UMB Project Manager.

## PART 3 - EXECUTION

### 3.1 HYDRONIC PIPING SYSTEMS

A. The Contractor conducting the test shall use this Test Procedure for Hydronic Piping systems. Test each pipe system as a whole or in segments as required by progress of the work. Perform tests prior to installation of piping insulation.

B. All Piping Systems include piping exposed and concealed above grade within the building, piping below floor slabs within the building, piping below grade five (5) feet beyond the exterior foundation wall, and/or piping above the building roof elevation and are defined as follows:

1. Hydronic Piping Systems include all Chilled Water Piping.

C. Use ambient temperature water as the testing medium, except where there is a risk of damage due to freezing. Another liquid may be used if it is safe for workmen and compatible with the piping system components.

D. Use vents installed at high points in the system to release trapped air while filling the system. Use drains installed at low points for complete removal of the liquid.

E. Examine system to see that equipment and parts that cannot withstand test pressures are properly isolated. Examine test equipment to ensure that it is tight and that low pressure filling lines are disconnected.

F. Subject piping system to a hydrostatic test pressure which at every point in the system is not less than one and one half (1-1/2) times the design pressure. The test pressure shall not exceed the maximum pressure for any vessel, pump, valve, or other component in the system under test. Make a check to verify that the stress due to pressure at the bottom of vertical runs does not exceed either 90% of specified minimum yield strength, or 1.7 times the "SE" value in Appendix A of ASME B31.9, Code for Pressure Piping, Building Services Piping.

G. After the hydrostatic test pressure has been applied for four (4) hours and with no allowable drop in pressure, the tested system or segment has passed the leak test. If after the four (4) hour test period there is a drop in pressure the contractor shall examine piping, joints, and connections for leakage. After the leaks have been corrected by tightening, repairing, and/or replacing components as appropriate, the hydrostatic test shall be rescheduled with UMB. The test procedure shall be repeated as specified above until there are no leaks and there is no allowable drop in pressure.

H. Test and certify that each backflow preventer has been provided in accordance with the local plumbing code and requirements of the authority having jurisdiction. Prepare and submit a certification form for each backflow preventer to the authority having jurisdiction.

3.2 REFRIGERANT PIPING SYSTEMS

A. The Contractor conducting the test shall use this Test Procedure for Refrigerant Piping Systems. Test each pipe system as a complete system. Testing this piping system in segments is not permitted. Inspect, test and perform corrective action of refrigerant piping in accordance with ASME Code B31.5, Chapter VI and as follows:

1. All refrigerant tubing shall be tested before tube insulation is applied.
2. Note: The use of compressed air for pressure testing refrigerant will not be permitted.
3. Refrigerant relief valves, if installed, shall be removed prior to pressure testing and shell openings plugged. After system is tested and found to be completely tight, relief valves shall be reinstalled prior to system evacuation.

4. Each tubing system shall be pressure tested with dry nitrogen. Leaks shall be repaired by removing and remaking the defective joint. No caulking will be permitted. After repair of leaks, system shall be retested and proved tight.
5. Tubing shall be tested at a minimum of 300 psig on the high side and 225 psig on the low side for our (4) hours. Suggested procedure is as follows:

    a. Charge system with oil pumped dry nitrogen to a pressure of 100 psig. Make a soap bubble test of all joints and all connections. Mark all leaks, blow down and repair all leaks. After the leaks have been identified and corrected by tightening, repairing, or replacing components as appropriate, the pressure test shall be rescheduled with UMB. The test procedure shall be repeated as specified until there are no leaks and the system is proved to be absolutely air tight.
    b. After above test and repair, charge high side with R-22 gas to a pressure of 30 psig. Make a rapid leak check at this pressure using an electronic leak detector. If no leaks are found, raise pressure to 300 psig on the high side and 225 psig on the low side using oil pumped dry nitrogen.
    c. Leave nitrogen and refrigerant mixture overnight to permit mixing by diffusion. Check diffusion and leak tester operation by venting a flange or valve stem. Make a thorough leak test. After the leaks have been identified and corrected by tightening, repairing, or replacing components as appropriate, the pressure test shall be rescheduled with UMB. The test procedure shall be repeated as specified until there are no leaks and the system is proved to be absolutely air tight.
    d. After the refrigerant piping has been pressure tested and proven tight, and before pipe insulation is applied, the entire system shall be evacuated with a vacuum pump to remove air and moisture. Evacuation shall be performed with all spaces containing refrigerant piping or equipment at no lower than 50°F.
    e. Manual valves except those open to atmosphere shall be opened and all controls such as solenoids shall be jacked open. Any gauges or pressure controls which could be damaged by a deep vacuum shall be valved off. Seal caps on valves shall be in place and tight. Any valves open to atmosphere shall be closed and capped.
    f. The entire system shall be double evacuated to 1,500 microns Hg absolute (1.5 torr) as follows:

        1) When vacuum pump is started, vacuum should pull down fairly rapidly to 25,000 microns Hg absolute (28.94”). If vacuum does not pull below 25,000 microns, there are leaks in the system and leak test procedure must be repeated.
        2) At approximately 10,000 microns, evaporation of free water in the system will be rapidly accelerated and vacuum will tend to remain constant as evaporation rate begins to equal vacuum pump capacity. Depending on amount of water, ambient temperature and

vacuum pump capacity, it may take several hours to make any noticeable decrease in vacuum below 10,000 microns. During this period, apply heat to any low points or suspected points of moisture. Feel pipes for cold spots and apply heat.

3) Continue evacuation until a pressure of 1,500 microns (1.5 torr) minimum is reached, then break the vacuum and pressurize to 10 psig with oil pumped dry nitrogen as a holding charge until ready for charging.

4) Before the system is ready for charging, vent nitrogen holding charge to atmosphere and re-evacuate down to a minimum of 1,500 microns to verify removal of all moisture in the piping system. Break vacuum with refrigerant gas. Do not use liquid.

## 3.3 AIR DISTRIBUTION DUCT SYSTEMS

A. Test each duct system as a whole or in segments as required by progress of the work. The total allowable leakage shall not exceed 1% of the total system design airflow. Use test pressure of pressure – velocity classification as follows:

1. Low Pressure Supply Duct System Test Pressure: Positive Two (2.0 inches wg.
2. Low Pressure Return and Exhaust Duct Systems Test Pressure: Negative Two (2) inches wg.

B. When testing each duct system in segments, use the following proportioning method to determine allowable losses for each segment tested:

1. ALS = (SFS/SFW) (ALW) where:

a. ALS = Allowable Loss, Segment in Cubic Feet per Minute (CFM)
b. ALW = Allowable Loss, Whole System in Cubic Feet per Minute (CFM) (1% of the total system design flow)
c. SFS = Square Foot (Sq. Ft.) Surface Area, Segment of Ductwork.
d. SFW = Square Foot (Sq. Ft.) Surface Area, of the Whole System of Ductwork.

C. Where actual leakage for a segment falls below the ALS, excess allowable may be added to another system segment.

D. Provide test blank off plates between each segment to be tested and provide access doors as specified to permit the removal of the blank off places when the testing has been completed and approved by UMB.

E. Prior to testing, the Sheet Metal Contractor shall manually remove all debris from inside ductwork, plenums, and equipment. Do not use Fans to remove the debris. Verify that all duct mounted equipment, access doors, accessories, components are installed complete as specified. Set all Fire Dampers, Smoke Dampers, or Combination

Fire/Smoke Dampers in their proper position with "Fire Links" or other devices required for operation, in place and set.

F. Pressure test all non-welded duct systems (Supply, Return, Exhaust, Fresh Air, and Relief Air) from the Primary Air Handler, Return Air or Exhaust Fan to the diffusers and grilles. All Low Pressure duct systems shall be pressure tested prior to the duct insulation being installed or the duct systems being concealed in shafts.

G. If the leakage rate of a Tested Duct System or Segment exceeds the specified allowable leakage rate then that Duct System or Segment must be inspected for leaks. Each leak shall be clearly marked and re-sealed. After the sealant has set the contractor shall reschedule the test with the appropriate contractors and UMB representatives.

H. Test Procedures shall be as follows:

1. Test for leaks as follows:

a. Close off and seal all openings in the duct section to be tested. Connect the test apparatus to the duct by means of a section of flexible duct.
b. Calculate the allowable leakage rate for the duct system or duct segment to be tested using the specified allowable leakage rate and the air volume.
c. Start the blower with its inlet control damper closed.
d. Gradually open the inlet control damper until the pressure in the duct reaches the design duct operating pressure/class. Read and record the test pressure indicated on manometer (#1). Read and record the pressure differential across the orifice indicated on manometer (#2). Read and record the duct leakage rate in CFM form the appropriate calibration curve. If there is no leakage, the pressure differential will be zero (0).
e. If the test results indicate a leakage rate that exceeds the specified leakage rate the contractor and UMB Personnel shall survey all joint for audible leaks. Mark each location and repair the joints after shutting down the blower. After the sealant has set for at least twenty four (24) to thirty six (36) hours the contractor shall reschedule the test with all appropriate parties. Follow the procedures outlined in paragraphs a, b, c and d above. If the pressure test fails again the contractor shall repeat the entire process until the tested section passes the leak test.

## 3.4 UMB STANDARD TEST SUMMARY FORMS

A. General: Contractors shall use the UMB Standard Forms for Recording the Leak Test Results for all Duct and Pipe Systems Tested on this Project.

1. Duct System Sample Form: See the following pages for a sample of the UMB Standard Air Duct Leak Test Summary Form.
2. Pipe System Sample From: See the following pages for a sample of the UMB Standard Pipe System Leak Test Summary Form.

3. Availability: The standard test summary forms are available on the UMB Web Site at http://www.umaryland.edu/designandconstruction/, under the Documents Link.

Field Testing: For field testing download and copy the forms from the UMB web site.

END OF SECTION 231101

# SECTION 231123 – FACILITY NATURAL GAS PIPING

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:

1. Pipes, tubes, and fittings.
2. Piping specialties.
3. Piping and tubing joining materials.
4. Dielectric fittings.

### 1.3 DEFINITIONS

A. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

### 1.4 ACTION SUBMITTALS

A. Product Data: For each type of the following:

1. Piping specialties.
2. Dielectric fittings.

B. Shop Drawings: For facility natural-gas piping layout. Include plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

1. Shop Drawing Scale: 1/4 inch per foot.

C. Delegated-Design Submittal: For natural-gas piping and equipment indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans and details, drawn to scale, on which natural-gas piping is shown and coordinated with other installations, using input from installers of the items involved.

B. Site Survey: Plans, drawn to scale, on which natural-gas piping is shown and coordinated with other services and utilities.

C. Qualification Data: For qualified professional engineer.

D. Welding certificates.

E. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Handling Flammable Liquids: Remove and dispose of liquids from existing natural-gas piping according to requirements of authorities having jurisdiction.

B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.

1.8 PROJECT CONDITIONS

A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.

B. Interruption of Existing Natural-Gas Service: Do not interrupt natural-gas service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide purging and startup of natural-gas supply according to requirements indicated:

1. Submit a request to the Owner no fewer than five days in advance of proposed interruption of natural-gas service.

2. Do not proceed with interruption of natural-gas service without Owner's written permission.

1.9 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

B. Coordinate requirements for access panels and doors for valves installed concealed behind finished surfaces. Comply with requirements in Section 083113 "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Minimum Operating-Pressure Ratings:

1. Piping: 100 psig minimum unless otherwise indicated.

B. Delegated Design: Design restraints and anchors for natural-gas piping and equipment, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

2.2 PIPES, TUBES, AND FITTINGS

A. Steel Pipe: ASTM A53/A53M, black steel, Schedule 40, Type E or S, Grade B.
1. Wrought-Steel Welding Fittings: ASTM A234/A234M for butt welding and socket welding.
2. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

a. Material Group: 1.1.
b. End Connections: Threaded or butt welding to match pipe.
c. Lapped Face: Not permitted underground.
d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless steel underground.

3. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.

a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.

4. Mechanical Couplings:
a. Steel flanges and tube with epoxy finish.
b. Buna-nitrile seals.

c. Steel bolts, washers, and nuts.
d. Coupling shall be capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
e. Steel body couplings installed underground on plastic pipe shall be factory equipped with anode.

2.3 JOINING MATERIALS

A. Joint Compound and Tape: Suitable for natural gas.

B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

C. Brazing Filler Metals: Alloy with melting point greater than 1000 deg F complying with AWS A5.8/A5.8M. Brazing alloys containing more than 0.05 percent phosphorus are prohibited.

2.4 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:
1. Description:

a. Standard: ASSE 1079.
b. Pressure Rating: 125 psig minimum at 180 deg F.
c. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:
1. Description:

a. Standard: ASSE 1079.
b. Factory-fabricated, bolted, companion-flange assembly.
c. Pressure Rating: 125 psig minimum at 180 deg F.
d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:
1. Description:

a. Nonconducting materials for field assembly of companion flanges.
b. Pressure Rating: 150 psig.
c. Gasket: Neoprene or phenolic.
d. Bolt Sleeves: Phenolic or polyethylene.
e. Washers: Phenolic with steel backing washers.

2.5 LABELING AND IDENTIFYING

A. Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored yellow.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Close equipment shutoff valves before turning off natural gas to premises or piping section.

B. Inspect natural-gas piping according to NFPA 54 to determine that natural-gas utilization devices are turned off in piping section affected.

C. Comply with NFPA 54 requirements for prevention of accidental ignition.

3.3 OUTDOOR PIPING INSTALLATION

A. Comply with NFPA 54 for installation and purging of natural-gas piping.

B. Install underground, natural-gas piping buried at least 36 inches below finished grade. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

1. If natural-gas piping is installed less than 36 inches below finished grade, install it in containment conduit.

C. Steel Piping with Protective Coating:

1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.
2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
3. Replace pipe having damaged PE coating with new pipe.

D. Install fittings for changes in direction and branch connections.

3.4 PIPING JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Welded Joints:

1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
2. Bevel plain ends of steel pipe.
3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

D. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.

E. Flanged Joints: Install gasket material, size, type, and thickness appropriate for natural-gas service. Install gasket concentrically positioned.

3.5 HANGER AND SUPPORT INSTALLATION

A. Install hangers for steel piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

B. Support horizontal piping within 12 inches of each fitting.

C. Support vertical runs of steel piping to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.6 CONNECTIONS

A. Connect to utility's gas main according to utility's procedures and requirements.

B. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.

3.7 LABELING AND IDENTIFYING

A. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for piping and valve identification.

B. Install detectable warning tape directly above gas piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.8 PAINTING

A. Paint exposed, exterior metal piping with protective coating.

1. Alkyd System: MPI EXT 5.1D.

a. Prime Coat: Alkyd anticorrosive metal primer.
b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
c. Topcoat: Exterior alkyd enamel gloss.
d. Color: Yellow.

B. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.9 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
2. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
3. Install anchor bolts to elevations required for proper attachment to supported equipment.
4. Use 3000-psig, 28-day, compressive-strength concrete and reinforcement as specified in Section 033000 "Cast-in-Place Concrete."

3.10 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Test, inspect, and purge natural gas according to NFPA 54 and authorities having jurisdiction.

C. Natural-gas piping will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.11 OUTDOOR PIPING SCHEDULE

A. Underground natural-gas piping shall be the following:
1. Steel pipe with wrought-steel fittings and welded joints, or mechanical couplings. Coat pipe and fittings with protective coating for steel piping.

B. Aboveground natural-gas piping shall be the following:

1. Steel pipe with wrought-steel fittings and welded joints.

END OF SECTION 231123

**SECTION 232113 – HVAC PIPING SYSTEMS AND SPECIALTIES**

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this and all other sections of Division 23.

1.2 SUMMARY

A. This section includes the requirements for HVAC pipe and specialties above ground within the building, below grade to five (5) feet outside the building and includes the following:
   1. Steel water pipe and fittings.
   2. Copper water pipe and fittings.
   3. Refrigerant pipe and fittings.
   4. Joining materials.
   5. Dielectric fittings.
   6. Air control devices.
   7. Hydronic piping specialties.
   8. Refrigerant specialties.
   9. Flexible connectors.

1.3 ACTION SUBMITTALS

A. Product Data: For each specified product, include manufacturers cut sheets, dimensional data, performance data, installation instructions, and warranty information.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Piping layout, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

B. Suspended ceiling components.

   1. Other building services.
   2. Structural members.

C. Qualification Data: For Installer.

D. Welding certificates.

E. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Include a copy of each approved submittal along with any applicable maintenance data in the project operation and maintenance manual.

1.6 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installers of Pressure-Sealed Joints: Installers shall be certified by pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.
2. Fiberglass Pipe and Fitting Installers: Installers of RTRF and RTRP shall be certified by manufacturer of pipes and fittings as having been trained and qualified to join fiberglass piping with manufacturer-recommended adhesive.

B. Steel Support Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

C. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

1. Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

D. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

E. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."

F. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

G. ASME Compliance: Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp flash tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 01.

1.7 FIELD CONDITIONS

A. Interruption of Existing HVAC Systems: Interruption of HAVC systems in facilities occupied by Owner or others shall not be permitted unless approved by CM and UMB – PM. under the following conditions and then only after arranging to provide temporary HVAC services according to requirements indicated:

1. Notify the Construction Manager and the no fewer than five (5) days in advance of proposed interruption of the HVAC systems.

2. Do not interrupt HVAC services without Construction Manager's written permission.

1.8 WARRANTY/GUARANTEE

A. See Division 23, Specification Section “Basic Mechanical Requirements – HVAC” for warranty and guarantee requirements.

## PART 2 - PRODUCTS

2.1 GENERAL PRODUCT REQUIREMENTS

A. Material Design and Selection: HVAC water pipe, fittings, and specialties shall be designed and selected, for the intended use, in accordance with the sizes on the drawings and the requirements of this specification.

B. Acceptable Manufacturers: Acceptable manufacturers shall be as follows:

1. Steel Piping Systems: All steel pipe and fittings shall be by one (1) manufacturer.

a. Pipe: Mueller Industries, Wheatland Tube Company.
b. Grooved Pipe: Victaulic.
c. Fittings: Anvil, Victaulic.

2. Copper Tube Piping Systems:

a. Solder Joint Copper Tube and Fittings: All copper tube and/or fittings for solder joint application shall be by one manufacturer.

1) Mueller Industries

b. Press Type Copper Piping Systems: The basis of design is Viega ProPress copper piping system. Other acceptable manufacturers are:

1) Nibco Inc.
2) Elkhart Products Corporation – Apollo XPress.

3. Dielectric Fittings:

a. Unions: Watts, Zurn and Capitol Manufacturing Company.
b. Flanges: Watts, Zurn and Capitol Manufacturing Company.
c. Insulating Kits: Pipeline Seal and Insulator Company, Calpico, Inc.
d. Nipples: Victaulic, Precision Plumbing Products, Inc. and Elster Perfection

4. Air Control Devices:

a. Manual Air Vents: Armstrong, Bell and Gossett, Hoffman.
b. Automatic Air Vents: Armstrong, Bell and Gossett, Hoffman.

5. Hydronic Specialties:

a. Y Strainers: Mueller, Spirax Sarco, Hoffman, and Armstrong.
b. Basket Strainers: Mueller, Spirax Sarco, Hoffman, and Armstrong.

6. Flexible Connectors: Metraflex Corporation or approved equal

2.2 HVAC PIPE MATERIAL APPLICATION

A. General Application: All pipe, fittings and joint methods shall be as specified below:

B. HVAC Pipe Material Application Schedule:

| Pipe System | Pipe Material | Fitting Material | Joint Material |
|---|---|---|---|
| Chilled Water (Inside BLDG) | Copper Tube: ASTM B88, Type 'L', Seamless, Water Tube, hard drawn temper | 2" and Smaller: Copper Tube: ASTME B16.22, wrought copper or copper alloy solder joint, 150 lb. | 2" and Smaller: ASTM B32, alloy Sb5 (95 percent tin, and 5 percent antimony), with 0.2 percent maximum lead content |
| | | 1/2 inch to 2 inch Viega ProPress copper fittings with EPDM seals. (Contractor Option) | Press connection with EPDM sealing element. (Contractor Option) |
| | 2-1/2" and Larger: Steel Pipe: ASTM A53, Grade B, Schedule 40, black steel | 2-1/2" and Larger: Steel; ASTM A234, butt welded, long radius ells, and weld o lets. Flanges: ANSI B 16.5, weld neck, raised faced with gaskets. | 2-1/2" and Larger: Welded: Latest revision of Section IX, ASME Boiler Pressure Vessel Code, Filler material per AWS D10.12. |
| Chilled Water | Pipe: 2-1/2" to 12": Victaulic rolled grooved end schedule 40 black steel pipe, 150 lb. ANSI Class, ASTM F-1476 by Victaulic Corp. USA. (Contractors Option) | Fittings: Ductile Iron Grooved End Fittings for Elbows, Tees, Increasers, Reducers, 'Y' Fittings, conforming to ASTM A - 395, grade 65-45-15 (Contractors Option) | Joints: Vic Style 07 Zero - Flex Rigid Ductile Iron couplings with Grade 'E' EPDM gasket material, Carbon Steel Nuts and Bolts, conforming to |

| | | | |
|---|---|---|---|
| | | | ASTM A-395, Grade 65-45-15, ASTM A - 183. Vic Flange Adapters: Vic Style 743, Ductile Iron, conforming to ASTM A -536, grade 65-45-12. (Contractors Option) |

| Pipe System | Pipe Material | Fitting Material | Joint Material |
|---|---|---|---|
| Air Conditioning Condensate and Equipment Drains | Copper Drainage Tube; DWV, ASTM B306 | Wrought copper and Bronze drainage fittings, ASNI B16.29 | ASTM B32, alloy Sb5 (95 percent tin, and 5 percent antimony), with 0.2 percent maximum lead content |
| Refrigerant Piping System | Copper Tube: ASTM B280, 'ACR' Type 'L', Seamless, hard drawn soft annealed seamless, factory cleaned and capped prior to shipping. | ASNI B16.22, wrought copper fittings. | Brazed: AWS A5.8, Classification BCuP-3 Brazed (Silver) filler material. |

2.3 COPPER TUBE FITTINGS

A. Grooved, Mechanical-Joint, Wrought-Copper Fittings: ASME B16.22.

1. Grooved-End Copper Fittings: ASTM B 75, copper tube or ASTM B 584, bronze casting.
2. Grooved-End-Tube Couplings: Rigid pattern unless otherwise indicated; gasketed fitting. Ductile-iron housing with keys matching pipe and fitting grooves, EPDM gasket rated for minimum 230°F for use with housing, and steel bolts and nuts.

B. Copper or Bronze Pressure-Seal Fittings:

C. Copper, Mechanically Formed Tee Option: For forming T-branch on copper water tube.

D. Wrought-Copper Unions: ASME B16.22.

## 2.4 STEEL PIPE FITTINGS

A. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in "Piping Applications" Article.

B. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in "Piping Applications" Article.

C. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced as indicated in "Piping Applications" Article.

D. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.

E. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

1. Material Group: 1.1.
2. End Connections: Butt welding.
3. Facings: Raised face.

F. Grooved Mechanical-Joint Fittings and Couplings:

1. Joint Fittings: ASTM A 536, Grade 65-45-12 ductile iron; ASTM A 47/A 47M, Grade 32510 malleable iron; ASTM A 53/A 53M, Type F, E, or S, Grade B fabricated steel; or ASTM A 106/A 106M, Grade B steel fittings with grooves or shoulders constructed to accept grooved-end couplings; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
2. Couplings: Ductile- or malleable-iron housing and EPDM gasket of central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.

G. Steel Pressure-Seal Fittings:

1. Housing: Steel.
2. O-Rings and Pipe Stop: EPDM.
3. Tools: Manufacturer's special tool.
4. Minimum 300-psig working-pressure rating at 230°F.

H. Steel Pipe Nipples: ASTM A 733, made of same materials and wall thicknesses as pipe in which they are installed.

## 2.5 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos free, one eighth (1/8) inch maximum thickness unless otherwise indicated.

    a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
    b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

D. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.

E. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

F. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

2.6 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:

1. Description:

    a. Standard: ASSE 1079.
    b. Revise pressure rating in "Pressure Rating" Subparagraph below to suit Project, or insert other options for specific applications.
    c. Pressure Rating: 125 psig minimum at 180°F .
    d. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

1. Description:

    a. Standard: ASSE 1079.
    b. Factory-fabricated, bolted, companion-flange assembly.
    c. Pressure Rating: 125 psig minimum at 180°F.
    d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:

1. Description:

   a. Nonconducting materials for field assembly of companion flanges.
   b. Pressure Rating: 150 psig.
   c. Gasket: Neoprene or phenolic.
   d. Bolt Sleeves: Phenolic or polyethylene.
   e. Washers: Phenolic with steel backing washers.

E. Dielectric Nipples:

1. Description:

   a. Standard: IAPMO PS 66.
   b. Electroplated steel nipple, complying with ASTM F 1545.
   c. Pressure Rating: 300 psig at 225°F.
   d. End Connections: Male threaded or grooved.
   e. Lining: Inert and noncorrosive, propylene.

## 2.7 AIR-CONTROL DEVICES

A. Manual Air Vents:

1. Body: Bronze.
2. Internal Parts: Nonferrous.
3. Operator: Screwdriver or thumbscrew.
4. Inlet Connection: NPS 1/2.
5. Discharge Connection: NPS 1/8.
6. CWP Rating: 150 psig.
7. Maximum Operating Temperature: 225°F.

B. Automatic Air Vents:

1. Body: Bronze or cast iron.
2. Internal Parts: Nonferrous.
3. Operator: Noncorrosive metal float.
4. Inlet Connection: NPS 1/2.
5. Discharge Connection: NPS 1/4.
6. CWP Rating: 150 psig.
7. Maximum Operating Temperature: 240°F.

C. Air Purgers:

1. Body: Cast iron with internal baffles that slow the water velocity to separate the air from solution and divert it to the vent for quick removal.
2. Maximum Working Pressure: 150 psig.

3. Maximum Operating Temperature: 250°F.

2.8 HYDRONIC PIPING SPECIALTIES

A. Pipe Flange Gasket Materials - Not Steam Systems: Suitable for the chemical and thermal conditions of the piping system contents:

1. ASME B16.21, nonmetallic, flat, asbestos free, one eighth (1/8) inch (3mm) maximum thickness, except where thickness or specific material is indicated.

a. Full-Face Type: For flat-face, Class 125 cast-iron and cast-bronze flanges.
b. Narrow-Face Type: For raised-face, Class 250 cast-iron and steel flanges.

2. ASME B16.20 for grooved, ring-joint, steel flanges.
3. AWWA C110, rubber, flat face one eighth (1/8) inch (3 mm) thick, except where other thickness are indicated, and full-face or ring type, except where type is indicated.

B. Flange Bolts and Nuts:

1. Non-Steam Systems: ASME B18.2.1, carbon steel, except where other material is indicated.
2. Steam Systems: ASTM A193, B7, Hex Head Bolts; ASTM A194, 2H, Hex Nuts.

C. Unions: ANSI B16.39, Class 150, malleable iron; female pattern; brass to iron seat; ground joint. Threads shall conform to ANSI B1.20.1.

D. Y-Pattern Strainers:

1. Non-Steam and Condensate (Copper Piping two (2) inch and smaller)

a. Basis-of-Design Product: Subject to compliance with requirements, provide Mueller Model 352M or comparable product by one (1) of the acceptable manufacturers.
b. Body: ASTM A 126, Class B, cast bronze body with bolted cover and bottom drain connection.
c. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
d. Strainer Screen: 304 Stainless-steel, 20-mesh strainer, or perforated stainless-steel basket.
e. CWP Rating: 125 psig.
f. Blow-down drain with plugged valve and threaded hose connection

2. Non-Steam and Condensate (Copper Piping two and one half (2-1/2) inch and larger)

a. Basis-of-Design Product: Subject to compliance with requirements, provide Mueller Model 758, or comparable product by one (1) of the acceptable manufacturers.
b. Body: ASTM A 126, Class B, cast iron body with bolted cover and bottom drain connection.
c. End Connections: Flanged ends for NPS 2-1/2 and larger.
d. Strainer Screen: 304 Stainless-steel, 20-mesh strainer, or perforated stainless-steel basket. Screens for four (4) inch strainers shall have .062 size perforated openings. Screen for five (5) inch and larger strainers shall have .125 perforated openings.
e. Blow-down drain with plugged valve and threaded hose connection
f. CWP Rating: 200 psig.

3. Non-Steam and Condensate (Steel Piping two and one half (2-1/2) inch and larger)

a. Basis-of-Design Product: Subject to compliance with requirements, provide Mueller Model 758, or comparable product by one (1) of the acceptable manufacturers.
b. Body: ASTM A 126, Class B, cast iron body with bolted cover and bottom drain connection.
c. End Connections: Flanged ends for NPS 2-1/2 and larger.
d. Strainer Screen: 304 Stainless-steel, 20-mesh strainer, or perforated stainless-steel basket. Screens for four (4) inch strainers shall have .062 size perforated openings. Screen for five (5) inch and larger strainers shall have .125 perforated openings.
e. Blow-down drain with plugged valve and threaded hose connection
f. CWP Rating: 200 psig.

E. Basket Strainers:

1. Body: ASTM A 126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.
2. End Connections: flanged ends for NPS 2-1/2.
3. Strainer Screen: 40-mesh startup strainer, and perforated 304 stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig.
5. Blow-down drain with plugged valve and threaded hose connection

F. Stainless-Steel Bellow, Flexible Connectors:

1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
2. End Connections: Threaded or flanged to match equipment connected.
3. Performance: Capable of 3/4-inch misalignment.

4. CWP Rating: 150 psig.
5. Maximum Operating Temperature: 250°F.

G. Spherical, Rubber, Flexible Connectors:

1. Body: Fiber-reinforced rubber body.
2. End Connections: Steel flanges drilled to align with Classes 150 and 300 steel flanges.
3. Performance: Capable of misalignment.
4. CWP Rating: 150 psig.
5. Maximum Operating Temperature: 250°F.

H. Diverting Fittings: cast iron body with threaded ends, or wrought copper with solder ends; 125 psig working pressure, 250ºF maximum operating temperature. Indicate flow direction on fitting.

2.9 REFRIGERANT SYSTEM SPECIALTIES

A. Straight-Type Strainers:

1. Body: Welded steel with corrosion-resistant coating.
2. Screen: 100-mesh stainless steel.
3. End Connections: Socket or flare.
4. Working Pressure Rating: 500 psig.
5. Maximum Operating Temperature: 275°F.

B. Moisture/Liquid Indicators:

1. Body: Forged brass.
2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
3. Indicator: Color coded to show moisture content in ppm.
4. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
5. End Connections: Socket or flare.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 240°F.

C. Replaceable-Core Filter Dryers: Comply with ARI 730.

1. Body and Cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.
2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
3. Desiccant Media: Activated alumina.
4. Retain first subparagraph below for heat pumps.
5. Designed for reverse flow (for heat-pump applications).
6. End Connections: Socket.

7. Retain first subparagraph below for suction-line filter dryers.
8. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
9. Maximum Pressure Loss: 2 psig.
10. Rated Flow: <Insert tons.>
11. Working Pressure Rating: 500 psig.
12. Maximum Operating Temperature: 240°F.

D. Permanent Filter Dryers: Comply with ARI 730.

1. Body and Cover: Painted-steel shell.
2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
3. Desiccant Media: Activated alumina.
4. Retain first subparagraph below for heat pumps.
5. Designed for reverse flow (for heat-pump applications).
6. End Connections: Socket.
7. Retain first subparagraph below for suction-line filter dryers.
8. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
9. Maximum Pressure Loss: 2 psig.
10. Rated Flow: <Insert tons.>
11. Working Pressure Rating: 500 psig.
12. Maximum Operating Temperature: 240°F.

2.10 FLEXIBLE CONNECTORS

A. Stainless-Steel Bellows, Flexible Connectors:

1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforced, protective jacket.
2. End Connections: Threaded or flanged to match equipment connected.
3. Performance: Capable of three quarter (3/4) inch misalignment.
4. CWP Rating: 150 psig.
5. Maximum Operating Temperature: 250°F.

## PART 3 - EXECUTION

3.1 PIPING INSTALLATIONS

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Select system components with pressure rating equal to or greater than system operating pressure.

K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

L. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

M. Install piping at a uniform grade of 0.2 percent upward in direction of flow.

N. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

O. Install branch connections to mains using mechanically formed tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.

P. Install valves according to Division 23 Specification Section "Valves for HVAC Piping Systems."

Q. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

R. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

S. Install shutoff valve immediately upstream of each dielectric fitting.

T. Comply with requirements in Division 23 Specification Section "Identification for HVAC Piping and Equipment" for identifying piping.

U. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 23 Specification Section "Sleeve, Sleeve Seals and Escutcheons for HVAC Piping."

V. Retain first paragraph below for piping that penetrates an exterior concrete wall or concrete slab.

W. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 23 Specification Section "Sleeve, Sleeve Seals and Escutcheons for HVAC Piping."

3.2 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric unions.

C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges, flange kits, or nipples.

D. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.3 HANGERS AND SUPPORTS

A. Comply with requirements in Section "Hangers and Supports for HVAC Piping and Equipment" for hanger, support, and anchor devices. Comply with the following requirements for maximum spacing of supports.

B. Comply with requirements in Division 23 Specification Section "Vibration and Seismic Controls for HVAC" for seismic restraints.

3.4 PIPE JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

D. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8/A5.8M.

E. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

F. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.

G. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

H. Grooved Joints: Assemble joints with coupling and gasket, lubricant, and bolts. Cut or roll grooves in ends of pipe based on pipe and coupling manufacturer's written instructions for pipe wall thickness. Use grooved-end fittings and rigid, grooved-end-pipe couplings.

I. Pressure-Sealed Joints: Use manufacturer-recommended tool and procedure. Leave insertion marks on pipe after assembly.

## 3.5 TERMINAL EQUIPMENT CONNECTIONS

A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.

B. Install control valves in accessible locations close to connected equipment.

C. Install bypass piping with a ball valve around control valve. If parallel control valves are installed, only one bypass is required.

D. Install ports for pressure gauges and thermometers at coil inlet and outlet connections. Comply with requirements in Division 23 Specification Section "Meters and Gauges for HVAC Piping."

## 3.6 HYDRONIC SPECIALTIES INSTALLATION

A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

B. Install automatic air vents at high points of system piping in mechanical equipment rooms only. Install manual vents at heat-transfer coils and elsewhere as required for air venting.

## 3.7 EQUIPMENT CONNECTIONS

A. Size for supply and return piping connections shall be the same as or larger than equipment connections.

B. Install traps and control valves in accessible locations close to connected equipment.

C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.

D. Install vacuum breakers downstream from control valve, close to coil inlet connection.

E. Install a drip leg at coil outlet.

## 3.8 REFRIGERANT SPECIALTY APPLICATIONS

A. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.

B. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for device being protected:

1. Edit list below for equipment required for Project.
2. Solenoid valves.
3. Thermostatic expansion valves.
4. Hot-gas bypass valves.
5. Compressor.

C. Install filter dryers in liquid line between compressor and thermostatic expansion valve, and in the suction line at the compressor.

D. Consult refrigeration equipment manufacturer to determine the need for a receiver.

E. Install receivers sized to accommodate pump-down charge.

F. Install flexible connectors at compressors.

## 3.9 PIPE JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or welding, to prevent scale formation.

D. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."

1. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.
2. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.

F. Threaded Joints: Thread steel pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry-seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Steel pipe can be threaded, but threaded joints must be seal brazed or seal welded.

H. Welded Joints: Construct joints according to AWS D10.12/D10.12M.

I. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.10 ADJUSTING

A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.

B. Adjust high and low pressure switch settings to avoid short cycling in response to fluctuating suction pressure.

C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.

D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:

1. Open shutoff valves in process cooling water circuit.
2. Verify that compressor oil level is correct.
3. Open compressor suction and discharge valves.
4. Open refrigerant valves except bypass valves that are used for other purposes.
5. Check open compressor-motor alignment and verify lubrication for motors and bearings.

E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

3.11 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
4. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
3. Isolate expansion tanks and determine that hydronic system is full of water.
4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times the "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
5. After hydrostatic test pressure has been applied for at least ten (10) minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing.

C. Perform the following before operating the system:

1. Open manual valves fully.
2. Inspect pumps for proper rotation.
3. Set makeup pressure-reducing valves for required system pressure.
4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).

5. Set temperature controls so all coils are calling for full flow.
6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
7. Verify lubrication of motors and bearings.

3.12 CLEANING

A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris; repair damaged finishes, including chips, scratches, and abrasions.

B. Before adding chemicals to the system, isolate coils of heating and cooling equipment, and open bypasses.

C. Flushing portions of the system:

1. After a piping loop has been completed and prior to the installation of strainer baskets, flush that portion of the system. Connections shall be same size as piping being flushed, or one size smaller.
2. When a major section of the building has been completed, repeat the same procedure, except that pipe connections shall be limited to 1.5 inch.
3. Flushing shall remove sediment, scale, rust and other foreign substances.
4. After flushing, install strainers and pressure test system and make it tight.

D. Flushing building system: After the various portions of the piping system have been tested and flushed and system is substantially completed, fill the system completely with water, venting all trapped air, and operating the pump.

1. Open a drain at the low point of the system while replacing the water through the make-up at the same rate.
2. Continue flushing until clean water shows at the drain, but for not less than two hours.
3. After flushing, remove strainers and clean and replace them. Remove the bypass around the equipment and install control valves.

E. Chemical cleaning: Fill system with sufficient detergent and dispersant to remove dirt, oil, and grease.

1. Circulate for at least forty eight (48) hours.
2. Open a drain valve at the lowest point and bleed while the system continues to circulate. Assure that the automatic make-up valve is operating.
3. Continue until water runs clear and all chemicals are removed. Sample and test the water until pH is the same as pH of makeup water.
4. After chemical cleaning, remove strainers, clean and reinstall them.
5. Close bypasses and open valves to coils.

F. Submit certificate and test results.

END OF SECTION 232113

# SECTION 232114 – UNDERGROUND HVAC PIPING

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 23.

### 1.2 SUMMARY

A. This section includes the requirements for underground HVAC piping for campus chilled water system and specialties as follows:

1. Cased piping system.

### 1.3 PERFORMANCE REQUIREMENTS

A. Provide components and installation capable of producing hydronic piping systems with the following minimum working-pressure ratings:

1. Chilled-Water Piping: 100 psig at 200°F.

### 1.4 ACTION SUBMITTALS

A. Product Data: For each specified product, include manufacturers cut sheets, dimensional data, performance data, installation instructions, specified options, and warranty information.

### 1.5 INFORMATIONAL SUBMITTALS

A. Profile Drawings: Show system piping in elevation. Draw profiles at horizontal scale of not less than one (1) inch equals fifty (50) feet and at vertical scale of not less than one (1) inch equals five (5) feet. Indicate manholes and piping. Show types, sizes, materials, and elevations of other utilities crossing hydronic piping.

B. Qualification Data: For qualified Installer.

C. Welding certificates.

D. Material Test Reports: For conduit cased piping.

E. Source quality control reports.

F. Field quality control reports.

1.6 CLOSEOUT SUBMITTAL

A. Operation and Maintenance Data: Include a copy of each approved submittal along with any applicable maintenance data in the project operation and maintenance manual.

1.7 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX.

1. Comply with provisions in ASME B31.9, "Building Services Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

B. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.

1.8 CORRDINATION

A. Coordinate the installation of the underground chilled water service mains with all other trades that have work close to and/or in the same area of the project site.

1.9 FIELD CONDITIONS

A. Interruption of Existing Chilled Water Service: The existing chilled water service to facilities occupied by Owner or others shall not be interrupted by the contractor. When an interruption to the service is required the contractor shall notify the Construction Manager within thirty (30) days after the bid has been awarded. UMB will work with the CM to schedule the appropriate time for the interruption of the chilled water service.

1.10 WARRANTY/ GUARANTEE

A. See Division 23 Specification Section “Basic Mechanical Requirements – HVAC” for warranty and guarantee requirements.

**PART 2 - PRODUCTS**

2.1 GENERAL PRODUCT REQUIREMENTS

A. Material Design and Selection: Underground HVAC pipe, fittings, and specialties shall be designed and selected, for the intended use, in accordance with the sizes on the drawings and the requirements of this specification.

B. Acceptable Manufacturers: Acceptable manufacturers shall be as follows:

1. Cased Piping System: All cased pipe and fittings shall be by one (1) manufacturer.

a. Perma Pipe, Inc.
b. Insul Tek Piping Systems, Inc.
c. Thermal Pipe Systems.

2.2 HVAC PIPE MATERIAL APPLICATION

A. General Application: All pipe, fittings and joint methods shall be as specified below:

B. HVAC Pipe Material Application Schedule:

| Pipe System | Pipe Material | Fitting Material | Joint Material |
|---|---|---|---|
| Campus Chilled Water Loop Piping | Cased Piping System: Carrier Pipe: Schedule 40 Steel Pipe 12" and up: ASTM A53, Grade B, Standard Weight, black steel pipe Casing: HDPE0.100 inch. | 12" and up; Schedule 40 Pipe Fittings ASTM A234, butt welded, long radius ells, and weld o lets. | 12" and up: Welded: Latest revision of Section IX, ASME Boiler Pressure Ves-sel Code, Filler ma-terial per AWS D10.12 |

2.3 CASED PIPING SYSTEM INSULATION AND ACCESSORIES

A. Carrier Pipe Insulation:

1. Basis of Design Product: Subject to compliance with requirements, provide perma-pipe xtru-therm or comparable product.

2. Polyurethane Foam Pipe Insulation: Rigid, cellular, high pressure injected between carrier pipe and jacket.

a. Comply with ASTM C 591; thermal conductivity (k-value) shall not exceed 0.14 Btu x in./h x sq. ft. x °F at 75°F after one hundred eighty (180) days of aging.

B. Casing accessories include the following:

1. Joint Kit: Half shell, pourable or split insulation, casing sleeve, and shrink-wrap sleeve.
2. Expansion Blanket: Elastomeric foam, formed to fit over piping.
3. End Seals: Shrink wrap the casing material to seal watertight around casing and carrier pipe.

C. Source Quality Control: Factory test the carrier pipe to 150% of the operating pressure of system. Furnish test certificates.

2.4 JOINING MATERIALS

A. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.5 UNDERGROUND PIPE – DETECTABLE WARNING TAPE

A. Detectable Warning Tape: Acid and alkali resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of six (6) inches wide and four (4) mils thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to thirty (30) inches deep; colored yellow.

**PART 3 - EXECUTION**

3.1 EARTHWORK

A. See Division 31 Specification Section "Earth Moving" and Division 33 Section Specification Section “Common Work Results for Utilities” for excavating, trenching, and backfilling requirements.

3.2 EXAMINATION

A. Examine roughing in’s for HVAC piping system to verify actual locations of piping connections to the existing campus underground HVAC piping and the building before installing the new piping.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Remove standing water in the bottom of trench.

C. Do not backfill piping trench until field quality control testing has been completed and results approved.

D. Install piping free of sags and bends.

E. Install fittings for changes in direction and branch connections.

F. See Division 23 Specification Section "Sleeves, Sleeve Seals and Escutcheons for HVAC Piping" for sleeves and mechanical sleeve seals through exterior building walls.

G. Secure anchors with concrete thrust blocks. Concrete is specified in Architectural Specification Section "Cast in Place Concrete."

3.4 PIPING JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Welded Joints:

1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
2. Bevel plain ends of steel pipe.
3. Patch factory applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

3.5 LABELING AND IDENTIFYING

A. Comply with requirements in Division 23 Specification Section "Identification for HVAC Systems and Equipment" for piping and valve identification.

B. Install detectable warning tape directly above piping, twelve (12) inches below finished grade, except six (6) inches below subgrade under pavements and slabs.

3.6 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to seismic codes at Project.

1. Construct concrete bases of dimensions indicated, but not less than four (4) inches larger in both directions than supported unit.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on eighteen (18) inch centers around the full perimeter of the base.
3. Install epoxy coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

5. Install anchor bolts to elevations required for proper attachment to supported equipment.

B. Use three thousand (3,000) psig, twenty eight (28) day, compressive strength concrete and reinforcement as specified in Architectural Specification Section "Miscellaneous Cast in Place Concrete."

3.7 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.

D. Pressure Sealed Joints: Use manufacturer recommended tool and procedure. Leave insertion marks on pipe after assembly.

3.8 GENERAL INSTALLATION REQUIREMENTS

A. Comply with ANSI/IEEE C2 and NFPA 70.

B. Make connections to ferrous pipe using exothermic welding.

C. Coat welds with the coating repair material and apply an exothermic weld cap.

3.9 IDENTIFICATION

A. Install continuous plastic underground warning tapes during back filling of trenches for underground hydronic piping. Locate tapes six (6) to eight (8) inches below finished grade, directly over piping.

3.10 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

D. Tests and Inspections:

1. Prepare hydronic piping for testing according to ASME B31.9 and as follows:

a. Leave joints, including welds, uninsulated and exposed for examination during test.
b. Fill system with water. Where there is risk of freezing, air or a safe, compatible liquid may be used.
c. Use vents installed at high points to release trapped air while filling system.

2. Test hydronic piping as follows:

a. Subject hydronic piping to hydrostatic test pressure that is not less than one and one half (1.5) times the design pressure.
b. After hydrostatic test pressure has been applied for ten (10) minutes, examine joints for leakage. Remake leaking joints using new materials and repeat hydrostatic test until no leaks exist.

E. Prepare test and inspection reports.

3.11 CLEANING

A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris; repair damaged finishes, including chips, scratches, and abrasions.

B. Flushing portions of the system:

1. After a piping loop has been completed and prior to the installation of strainer baskets, flush that portion of the system. Connections shall be same size as piping being flushed, or one size smaller.
2. Flushing shall remove sediment, scale, rust and other foreign substances.
3. After flushing pressure test system and make it tight.

C. Flushing building system: After the various portions of the piping system have been tested and flushed and system is substantially completed, fill the system completely with water, venting all trapped air, and operating the pump.

1. Open a drain at the low point of the system while replacing the water through the make-up at the same rate.
2. Continue flushing until clean water shows at the drain, but for not less than two hours.

D. Chemical cleaning: Fill system with sufficient detergent and dispersant to remove dirt, oil, and grease.

1. Circulate for at least forty eight (48) hours.
2. Open a drain valve at the lowest point and bleed while the system continues to circulate. Assure that the automatic make-up valve is operating.
3. Continue until water runs clear and all chemicals are removed. Sample and test the water until pH is the same as pH of makeup water.
4. After chemical cleaning, remove strainers, clean and reinstall them.
5. Close bypasses and open valves to coils.

E. Submit certificate and test results.

END OF SECTION 232114

# SECTION 233113 – HVAC DUCT SYSTEMS AND ACCESSORIES

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 23.

### 1.2 SUMMARY

A. This section includes the requirements for HVAC Duct Systems and related accessories as follows:

1. Sheet metal materials.
2. Sealants and gaskets.
3. Single-wall rectangular ducts and fittings.
4. Hangers and supports.
5. Backdraft dampers.
6. Manual volume dampers.
7. Fire dampers.
8. Smoke dampers.
9. Combination fire and smoke dampers.
10. Duct-mounted access doors.
11. Flexible connectors.
12. Flexible ducts

### 1.3 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.

B. Structural Performance: Duct hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible".

C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

### 1.4 ACTION SUBMITTALS

A. Product Data: For each specified product, include manufacturers cut sheets, dimensional data, performance data, installation instructions, wirings diagrams, power requirements, specified options, and warranty information.

B. For each type of the following products:

1. Construction details for ductwork and fittings.
2. Adhesives.
3. Sealants and gaskets.

C. Shop Drawings:

1. Factory- and shop-fabricated ducts and fittings.
2. Duct static-pressure classes.
3. Seam and joint construction.
4. Duct accessories, including dampers, turning vanes, and access doors and panels.
5. Hangers and supports, including methods for duct and building attachment and vibration isolation.

1.5 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Field quality-control reports.

1.6 CLOSEOUT SUBMITTAL

A. Operation and Maintenance Data: Include a copy of each approved submittal along with any applicable maintenance data in the project operation and maintenance manual.

1.7 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

B. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
2. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."

D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

1.8 WARRANTY/GUARANTEE

A. See Division 23 Specification Section “Basic Mechanical Requirements – HVAC” for warranty and guarantee requirements.

## PART 2 - PRODUCTS

### 2.1 GENERAL PRODUCT REQUIREMENTS

A. Material Design and Selection: HVAC Duct Systems and Accessories shall be designed and selected, for the intended use, in accordance with the sizes on the drawings and the requirements of this specification.

### 2.2 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G90.
2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Aluminum Sheets: Comply with ASTM B 209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.

D. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

E. Tie Rods: Galvanized steel, one quarter (1/4) inch minimum diameter for lengths thirty six (36) inches or less; three eights (3/8) inch minimum diameter for lengths longer than thirty six (36) inches.

### 2.3 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of twenty five (25) and a maximum smoke-developed index of fifty (50) when tested according to UL 723; certified by an NRTL.

B. Two (2) Part Tape Sealing System:

1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
2. Tape Width: Three (3) inches.
3. Sealant: Modified styrene acrylic.
4. Water resistant.
5. Mold and mildew resistant.
6. Maximum Static-Pressure Class: Ten (10) inch wg. positive and negative.
7. Service: Indoor and outdoor.
8. Service Temperature: - 40°F to +200°F.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
10. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
11. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 65%.
3. Shore A Hardness: Minimum Twenty (20).
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: Ten (10) inch wg, positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

D. Flanged Joint Sealant: Comply with ASTM C 920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: Twenty five (25).
5. Use: O.
6. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

F. Round Duct Joint O-Ring Seals:

1. Seal shall provide maximum leakage class of three (3) cfm/100 sq. ft. at one (10) inch wg. and shall be rated for ten (10) inch wg static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

G. Duct Connection Joint Sealant: For renovation projects where new ductwork connects to existing ductwork provide the following material as a joint sealer between the new and existing duct surfaces:

1. Permatite, Butyl gray non curing tape of sufficient width to seal the duct joints. Material can be purchased from the manufacturer or from Grainger using the either the manufacturers model number DS5285, or the Grainger item number 2EJR3. Seal the external joints as required by these specifications and the ductwork can be placed in service.

## 2.4 SINGLE WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

E. Crossbreaking or Cross Beading: Crossbreak or bead duct sides that are nineteen (19) inches and larger and are 20 gauge or less, with more than ten (10) sq. ft. of unbraced panel area, as indicated in SMACNA "HVAC Duct Construction Standard," Figure 1-4, unless they are lined or are externally insulated.

2.5 SINGLE WALL ROUND DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

a. Lindab Inc.
b. McGill AirFlow LLC.
c. SEMCO Incorporated.
d. Sheet Metal Connectors, Inc.
e. Spiral Manufacturing Co., Inc.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Transverse Joints in Ducts Larger Than sixty (60) Inches in Diameter: Flanged.

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Fabricate round ducts larger than ninety (90) inches in diameter with butt-welded longitudinal seams.
2. Fabricate flat-oval ducts larger than seventy two (72) inches in width (major dimension) with butt-welded longitudinal seams.

D. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

E. Elbows: Fabricate in die-formed, gored, pleated, or mitered construction. Fabricate the bend radius of die-formed, gored, and pleated elbows one and one half (1.5) times the elbow

diameter. Unless elbow construction type is indicated, provide elbows meeting the following requirements:

F. Mitered Elbows: Fabricate mitered elbows with welded construction in gauges specified below:

1. Mitered Elbows Radius and Number of Pieces: Unless otherwise indicated, construct elbow to comply with SMACNA "HVAC Duct Construction Standards," Table 3-1.
2. Round Mitered Elbows: Solid welded and with metal thickness listed below for pressure classes from minus two (2) inches to plus two (2) inches:

   a. Three (3) inches to twenty six (26) inches: 24 gauge.
   b. Twenty seven (27) inches to thirty six (36) inches: 22 gauge.
   c. Thirty seven (37) inches to fifty (50) inches: 20 gauge.
   d. Fifty two (52) inches to sixty (60) inches: 18 gauge.
   e. Sixty two (62) inches to eighty four (84) inches: 16 gauge.

G. Round Mitered Elbows: Solid welded and with metal thickness listed below for pressure classes from two (2) inches to ten (10) inches:

1. Three (3) inches to fourteen (14) inches: 24 gauge.
2. Fifteen (15) inches to twenty six (26) inches: 22 gauge.
3. Twenty seven (27) inches to fifty (50) inches: 20 gauge.
4. Fifty two (52) inches to sixty (60) inches: 18 gauge.
5. Sixty two (62) inches to eighty four (84) inches: 16 gauge.

H. 90-Degree, Two (2) Piece, Mitered Elbows: Use only for supply systems, or exhaust systems for material handling classes A and B, and only where space restrictions do not permit the use of one and one half (1.5) bend radius elbows. Fabricate with a single-thickness turning vanes.

I. Round Elbows – Eight (8) Inches and Smaller: Die-formed elbows for 45- and 90-degree elbows and pleated elbows for 30, 45, 60, and 90 degrees only. Fabricate nonstandard bend angle configurations or one half (1/2) inch-diameter (e.g. 3-1/2- and 4-1/2-inch) elbows with gored construction.

J. Round Elbows – Nine (9) Inches Through Fourteen (14) Inches: Gored or pleated elbows for 30, 45, 60, and 90 degrees, except where space restrictions require a mitered elbow. Fabricate nonstandard bend angle configurations or 1/2-inch-diameter (e.g. 9-1/2- and 10-1/2-inch) elbows with gored construction.

K. Round Elbows - Larger Than Fourteen (14) Inches and All Flat Oval Elbows: Gored elbows, except where space restrictions require a mitered elbow.

L. Die-Formed Elbows for Sizes through Eight (8) Inches and All Pressures: 20 gauge with two (2) piece welded construction.

M. Round Gored Elbows Gages: Same as for nonelbow fittings specified above.

N. Pleated Elbows Sizes through Fourteen (14) Inches and Pressures through Ten (10) Inches: 26 gauge.

## 2.6 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.

F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

H. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

## 2.7 BACKDRAFT DAMPERS

A. Light to Medium Duty (1,000 to 1,500 FPM maximum velocity)

1. Basis-of-Design Product: Subject to compliance with requirements, Ruskin BD2/A1 and Ruskin BD2/A2 or comparable product by one (1) of the following:

a. American Warming and Ventilating; a division of Mestek, Inc.
b. Greenheck Fan Corporation.
c. Ruskin Company.

2. Description: Gravity balanced.
3. Operation Pressure: BD2A1 blades open at 0.03 in. wg. and are fully open at 0.10 inch wg. BD2A2 blades open at 0.10 inch wg. and are fully open at 0.15 inch w.g.
4. Frame: Hat-shaped, 0.090-inch-thick extruded aluminum, with mitered corners.
5. Blades: (1000 FPM maximum velocity) -. Ruskin BD2/A1, 0.025 inch formed aluminum, extruded vinyl edge seals. (1,500 FPM maximum velocity) - Ruskin BD2/A2, 6063T5 extruded aluminum, 0.050 inch wall thickness, extruded vinyl edge seals.
6. Blade Action: Parallel.
7. Blade Seals: Extruded vinyl, mechanically locked.
8. Blade Axles:

    a. Material: Nonferrous metal.
    b. Diameter: 0.20 inch.

9. Return Spring: Adjustable tension.
10. Bearings: synthetic pivot bushings.
11. Accessories:

    a. Electric actuators.
    b. Screen Mounting: Rear mounted.
    c. Screen Material: Galvanized steel.
    d. Screen Type: Bird.

B. Heavy Duty Backdraft Dampers (1,500 to 2,500 FPM maximum velocity)

1. Basis-of-Design Product: Subject to compliance with requirements, Ruskin BDG or comparable product by one (1) of the following:

    a. American Warming and Ventilating; a division of Mestek, Inc.
    b. Greenheck Fan Corporation.
    c. Ruskin Company.

2. Description: Gravity balanced.
3. Operation Pressure: Blades open at 0.12 inch wg. And are fully open at .20 inch wg.
4. Frame: Hat-shaped, 0.0125-inch-thick extruded aluminum, with galvanized steel braced corners.
5. Blades: Extruded aluminum 0.070 inch wall thickness.
6. Blade Action: Parallel.
7. Blade Seals: Extruded vinyl mechanically locked.
8. Blade Axles:

    a. Material: Nonferrous metal.
    b. Diameter: 0.20 inch.

9. Tie Bars and Brackets: Aluminum.
10. Return Spring: Adjustable tension.
11. Bearings: synthetic pivot bushings.
12. Accessories:

    a. Electric actuators.
    b. Adjustable static pressure control.
    c. Screen Mounting: Rear mounted.
    d. Screen Material: Galvanized steel.
    e. Screen Type: Bird.

C. Counterbalanced Backdraft Dampers

1. Basis-of-Design Product: Subject to compliance with requirements, provide Ruskin CBD2 or comparable product by one (1) of the following:

    a. American Warming and Ventilating; a division of Mestek, Inc.
    b. Greenheck Fan Corporation.
    c. Ruskin Company.

D. Description: Gravity balanced.

E. Maximum System Pressure: Max0.04 inch wg. at 1,000 feet per minute

F. Frame: Hat-shaped, 0.090-inch- thick, extruded aluminum, with welded corners or mechanically attached and mounting flange.

G. Blades: Multiple single-piece blades, maximum 6-inch width, 0.025-inch-thick, roll-formed aluminum with sealed edges.

H. Blade Action: Parallel.

I. Blade Seals: Extruded vinyl, mechanically locked.

J. Blade Axles:

1. Material: Synthetic
2. Diameter: 0.20 inch.

K. Tie Bars and Brackets: Aluminum.

L. Return Spring: Adjustable tension.

M. Bearings: synthetic pivot bushings.

N. Accessories:

1. Adjustment device to permit setting for varying differential static pressure.

2. Counterweights and spring-assist kits for vertical airflow installations.

## 2.8 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Ruskin Model No. CD36 or comparable product by one (1) of the following:

   a. American Warming and Ventilating; a division of Mestek, Inc.
   b. Greenheck Corporation.
   c. Ruskin Company.

2. Standard leakage rating, with linkage outside airstream.
3. Suitable for horizontal or vertical applications.
4. Frames:

   a. Frame: Hat-shaped, 0.094-inch- thick, galvanized sheet steel.
   b. Mitered and welded corners.
   c. Flanges for attaching to walls and flangeless frames for installing in ducts.

5. Blades:

   a. Multiple blade with three longitudinal grooves for reinforcement.
   b. Parallel or opposed-blade design.
   c. Stiffen damper blades for stability.
   d. Galvanized-steel, 0.064 inch thick.

6. Blade Axles: Galvanized steel.
7. Bearings:

   a. Molded synthetic.
   b. Dampers in ducts with pressure classes of three (3) inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.

8. Tie Bars and Brackets: Galvanized steel.

B. Low-Leakage, Steel, Manual Volume Dampers:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Ruskin Model No. CD60 or comparable product by one (1) of the following:

   a. American Warming and Ventilating; a division of Mestek, Inc.
   b. Greenheck Corporation.
   c. Ruskin Company.

2. Comply with AMCA 500-D testing for damper rating.
3. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.

4. Suitable for horizontal or vertical applications.
5. Frames:

    a. Hat shaped.
    b. 0.094-inch-thick, galvanized sheet steel.
    c. Mitered and welded corners.
    d. Flanges for attaching to walls and flangeless frames for installing in ducts.

6. Blades:

    a. Multiple blade six (6) inch wide.
    b. Parallel or opposed-blade design.
    c. Stiffen damper blades for stability.
    d. Galvanized, roll-formed steel, 0.064 inch thick.

7. Blade Axles: Galvanized steel.
8. Bearings:

    a. Molded synthetic.
    b. Dampers in ducts with pressure classes of three (3) inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.

9. Blade Seals: Neoprene.
10. Jamb Seals: Cambered stainless steel.
11. Tie Bars and Brackets: Galvanized steel.
12. Accessories:

    a. Include locking device to hold single-blade dampers in a fixed position without vibration.

C. Low-Leakage, Aluminum, Manual Volume Dampers:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Ruskin Model CD50 or comparable product by one (1) of the following:

    a. American Warming and Ventilating; a division of Mestek, Inc.
    b. Greenheck Corporation.
    c. Ruskin Company.

2. Comply with AMCA 500-D testing for damper rating.
3. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
4. Suitable for horizontal or vertical applications.
5. Frames: Hat-shaped, 0.10-inch- thick, aluminum sheet channels; frames with flanges for attaching to walls and flangeless frames for installing in ducts.
6. Blades:

a. Multiple 6 inch wide.
b. Parallel- or opposed-blade design.
c. Roll-Formed Aluminum Blades: 0.10-inch-thick aluminum sheet.
d. Extruded-Aluminum Blades: 0.050-inch-thick extruded aluminum.

7. Blade Axles: Galvanized steel.
8. Bearings:

a. Molded synthetic.
b. Dampers in ducts with pressure classes of three (3) inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.

9. Blade Seals: Neoprene, replaceable.
10. Jamb Seals: Cambered stainless steel.
11. Tie Bars and Brackets: Galvanized steel.
12. Accessories:

a. Include locking device to hold single-blade dampers in a fixed position without vibration.

D. Jackshaft:

1. Size: 0.5-inch diameter.
2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

E. Damper Hardware:

1. Zinc-plated, die-cast core with dial and handle made of three thirty second (3/32) inch- thick zinc-plated steel, and a three quarter (3/4) inch hexagon locking nut.
2. Include center hole to suit damper operating-rod size.
3. Include elevated platform for insulated duct mounting.

## 2.9 FIRE DAMPERS

A. Static Type Fire Damper:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Ruskin IBDD2 or comparable product by one (1) of the following:

a. Air Balance Inc.; a division of Mestek, Inc.
b. Ruskin Company.
c. United Sheet Metal.

2. Type: Rated and labeled according to UL 555 by an NRTL.

3. Closing rating in ducts up to four (4) inch wg static pressure class and minimum 2000-fpm velocity.
4. Fire Rating: One and one half (1-1/2) hours.
5. Frame: Curtain type with blades outside airstream; fabricated with roll-formed, four and seven eighth (4-7/8) inches wide, 20 gauge galvanized steel channel complete with integral 20 gauge galvanized steel sleeve with twelve (12) inch, fourteen (14) inch, or sixteen (16) inch length as required to suit wall construction. Sleeve may be omitted if wall thickness matches damper construction per UL 555.
6. Mounting Orientation: Vertical or horizontal as indicated.
7. Blades: Roll-formed, interlocking, 0.024-inch-thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch-thick, galvanized-steel blade connectors.
8. Horizontal Dampers: Include blade lock and stainless-steel closure spring.
9. Heat-Responsive Device: Replaceable, 165°F rated, fusible links.

B. Dynamic Type Fire Damper:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Ruskin DIBD2 or comparable product by one (1) of the following:
   a. Air Balance Inc.; a division of Mestek, Inc.
   b. Ruskin Company.
   c. United Sheet Metal.

2. Type: Dynamic; rated and labeled according to UL 555 by an NRTL.
3. Closing rating in ducts up to four (4) inch wg static pressure class and minimum 2,000-fpm velocity.
4. Fire Rating: One and one half (1-1/2) hours.
5. Frame: Curtain type with blades outside airstream; fabricated with roll-formed, four and seven eight (4-7/8) inches wide, 20 gauge galvanized steel channel complete with integral 20 gauge galvanized steel sleeve with twelve (12) inch, fourteen (14) inch, or sixteen (16) inch length as required to suit wall construction. Sleeve may be omitted if wall thickness matches damper construction per UL 555.
6. Mounting Orientation: Vertical or horizontal as indicated.
7. Blades: Roll-formed, interlocking, 0.024-inch-thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch-thick, galvanized-steel blade connectors.
8. Horizontal Dampers: Include blade lock and stainless-steel closure spring.
9. Heat-Responsive Device: Replaceable, 165°F rated, fusible links.

## 2.10 SMOKE DAMPERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Ruskin SDRS25 and SDS60 for round and square multiple blade models or comparable product by one (1) of the following:

1. Air Balance Inc.; a division of Mestek, Inc.
2. Ruskin Company.
3. United Sheet Metal.

B. General Requirements: Label according to UL 555S by an NRTL.

C. Smoke Detector: Integral, factory wired for single-point connection.

D. Frame: Hat-shaped, 16 gauge, galvanized sheet steel, with welded or mechanically attached corners and mounting flange.

E. Blades: two (2) piece 14 gauge (round), one piece airfoil (square), thick, galvanized sheet steel.

F. Leakage: Class I.

G. Rated pressure and velocity: Four (4) inch wg. in the closed position and 3,500 FPM in the open position.

H. Blade Seals: Silicone edge type, mechanical fastened to the blade edge, for smoke seal to 450°F.

I. Bearings: Stainless steel, sleeve type.

J. Mounting Sleeve: Factory-installed, 0.05-inch- thick, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone calking.

K. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Specification Section "Motor Requirements for HVAC Equipment."

L. Accessories:

1. Auxiliary switches for signaling fan control or position indication.
2. Test and reset switches, damper mounted.

## 2.11 COMBINATION FIRE AND SMOKE DAMPERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Ruskin FSD60, FSD60-2, FSD60-3 or comparable product by one (1) of the following:

1. Air Balance Inc.; a division of Mestek, Inc.
2. Ruskin Company.
3. United Sheet Metal.

B. Type: Dynamic; rated and labeled according to UL 555 and UL 555S by an NRTL.

C. Closing rating in ducts up to four (4) inch wg static pressure class and minimum 2,000-fpm velocity.

D. Fire Rating: One and one half (1-1/2) hours.

E. Frame: Hat-shaped, 0.094-inch-thick, galvanized sheet steel.

F. Heat-Responsive Device: Resettable, 165°F rated.

G. Actuator: Electric or pneumatic - actuator shall be specified and provided under Division 23 Specification Sections for the "Building Automation Systems" for factory mounting during smoke damper fabrication. Each damper shall be provided with a blade position indicator linked directly to the damper blade to remotely indicate damper position to the ATC/Fire alarm system as required under system operating sequences or as indicated Damper and actuator shall be successfully factory cycled ten (10) times. Each assembly shall be equipped with a controlled seven (7) to fifteen (15) second heat actuated release device allowing the damper to close and lock during test, smoke detection, power failure or fire conditions. Dampers shall be capable of automatic remote reset.

H. Smoke Detector: Integral, factory wired for single-point connection.

I. Vertical blades are available for special applications.

J. Blades: One piece air foil, 16 gauge, galvanized sheet steel.

K. Leakage: Class I.

L. Rated pressure and velocity to exceed design airflow conditions.

M. Mounting Sleeve: Factory-installed, 0.039-inch thick, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone calking.

N. Master control panel for use in dynamic smoke-management systems.

O. Damper Motors: Two (2) position action.

P. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section "Common Motor Requirements for HVAC Equipment."

Q. Accessories:

1. Auxiliary switches for signaling fan control or position indication.
2. Test and reset switches, damper mounted.

## 2.12 DUCT-MOUNTED ACCESS DOORS

A. Manufacturers: Subject to compliance with requirements provide products by one (1) of the following:

1. Air Balance, Inc.
2. Ruskin.
3. United Sheet Metal

B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2, "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."

1. Door:

a. 22 gauge, double wall, rectangular.
b. Galvanized sheet metal with 1 inch thick fiberglass insulation.
c. Hinges and Latches: Continuous piano hinge and cam latches.
d. Fabricate doors airtight and suitable for duct pressure class.

2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.

## 2.13 FLEXIBLE CONNECTORS

A. Manufacturers: Subject to compliance with requirements products by one (1) of the following:

1. Ductmate Industries, Inc.
2. Duro Dyne Inc.
3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Materials: Flame-retardant or noncombustible fabrics.

C. Coatings and Adhesives: Comply with UL 181, Class 1.

D. Metal-Edged Connectors: Factory fabricated with a fabric strip three and one half (3-1/2) inches wide attached to two (2) strips of two and three quarter (2-3/4) inch wide, 0.028-inch thick, galvanized sheet steel or 0.032-inch thick aluminum sheets. Provide metal compatible with connected ducts.

E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

1. Minimum Weight: 26 oz./sq. yd.
2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
3. Service Temperature: - 40°F to + 200°F.

F. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.

1. Minimum Weight: 24 oz./sq. yd.
2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
3. Service Temperature: - 50°F to + 250°F.

2.14 FLEXIBLE DUCTS

A. Manufacturers: Subject to compliance with requirements provide products by one (1) of the following:

1. Flexmaster U.S.A., Inc.
2. McGill AirFlow LLC.
3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Insulated, Flexible Duct: UL 181, Class 1, black polymer film supported by helically wound, spring-steel wire; fibrous-glass insulation; aluminized vapor-barrier film.

1. Pressure Rating: four (4) inch wg. positive and 0.5-inch wg. negative.
2. Maximum Air Velocity: 4,000 fpm.
3. Temperature Range: - 20°F to + 175°F.
4. Insulation R-Value: Comply with ASHRAE/IESNA 90.1.

C. Flexible Duct Connectors:

1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes three (3) inches through eighteen (18) inches, to suit duct size.

**PART 3 - EXECUTION**

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install round ducts in maximum practical lengths.

D. Install ducts with fewest possible joints.

E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

H. Install ducts with a clearance of one (1) inch, plus allowance for insulation thickness.

I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least one and one half (1-1/2) inches.

K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers.

L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

## 3.2 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or No. 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

## 3.3 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

## 3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than four (4) inches thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than four (4) inches thick.
5. Do not use powder-actuated concrete fasteners for seismic restraints.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within twenty four (24) inches of each elbow and within forty eight (48) inches of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of sixteen (16) feet.

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

## 3.5 CONNECTIONS

A. Make connections to equipment with flexible connectors.

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

## 3.6 PAINTING

A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Architectural Specification Sections "Exterior Painting" and/or "Interior Painting."

## 3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Leakage Tests:

1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
2. Test the following systems:
    a. Supply Ducts with a Pressure Class of Two (2) Inch wg. or Higher: Test representative duct sections totaling no less than percent of total installed duct area for each designated pressure class.
    b. Return Ducts with a Pressure Class of Two (2) Inch wg. or Higher: Test representative duct sections totaling no less than 50% of total installed duct area for each designated pressure class.
    c. Exhaust Ducts with a Pressure Class of Two (2) Inch wg. or Higher: Test representative duct sections totaling no less than 50% of total installed duct area for each designated pressure class.
3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
4. Test for leaks before applying external insulation.
5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
6. Give seven days' advance notice for testing.

C. Duct System Cleanliness Tests:

1. Visually inspect duct system to ensure that no visible contaminants are present.
2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."
    a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.

D. Duct system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

## 3.8 START UP

A. Air Balance: Comply with requirements in Division 23 Specification Section "Testing, Adjusting, and Balancing HVAC Systems."

3.9 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:

B. Supply Ducts:

1. Pressure Class: Positive three (3) inch wg.
2. Minimum SMACNA Seal Class: A.
3. SMACNA Leakage Class for Rectangular: 6.
4. SMACNA Leakage Class for Round and Flat Oval: 3.

C. Return Ducts:

1. Pressure Class: Positive or negative two (2) inch wg.
2. Minimum SMACNA Seal Class: B.
3. SMACNA Leakage Class for Rectangular: 12.
4. SMACNA Leakage Class for Round and Flat Oval: 6.

D. Exhaust Ducts:

1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:

a. Pressure Class: Negative two (2) wg.
b. Minimum SMACNA Seal Class: B if negative pressure, and A if positive pressure.
c. SMACNA Leakage Class for Rectangular: 12.
d. SMACNA Leakage Class for Round and Flat Oval: 6.

E. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:

1. Pressure Class: Positive or negative two (2) wg.
2. Minimum SMACNA Seal Class: B.
3. SMACNA Leakage Class for Rectangular: 12.
4. SMACNA Leakage Class for Round and Flat Oval: 6.

F. Intermediate Reinforcement:

1. Galvanized-Steel Ducts: Galvanized steel.

2. Stainless-Steel Ducts:

a. Exposed to Airstream: Match duct material.
b. Not Exposed to Airstream: Match duct material.

3. Aluminum Ducts: Aluminum.

G. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

    a. Velocity 1,000 fpm or Lower:

        1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
        2) Mitered Type RE 4 without vanes.

    b. Velocity 1,000 to 1,500 fpm:

        1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
        2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
        3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

    c. Velocity 1,500 fpm or Higher:

        1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
        2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
        3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

    a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
    b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
    c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."

    a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.

1) Velocity 1,000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
2) Velocity 1,000 to 1,500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
3) Velocity 1,500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
4) Radius-to Diameter Ratio: 1.5.

b. Round Elbows, twelve (12) Inches and Smaller in Diameter: Stamped or pleated.
c. Round Elbows, fourteen (14) Inches and Larger in Diameter: Standing seam.

H. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."

a. Rectangular Main to Rectangular Branch: 45-degree entry.
b. Rectangular Main to Round Branch: Spin in.

2. Round: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.

a. Velocity 1,000 fpm or Lower: 90-degree tap.
b. Velocity 1,000 to 1500 fpm: Conical tap.
c. Velocity 1,500 fpm or Higher: 45-degree lateral.

3.10 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Install backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.

D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts.

1. Install steel volume dampers in steel ducts.
2. Install aluminum volume dampers in aluminum ducts.

E. Set dampers to fully open position before testing, adjusting, and balancing.

F. Install test holes at fan inlets and outlets and elsewhere as indicated.

G. Install fire and smoke dampers according to UL listing.

H. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:

1. On both sides of duct coils.
2. Upstream from duct filters.
3. At outdoor-air intakes and mixed-air plenums.
4. At drain pans and seals.
5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
7. At each change in direction and at maximum fifty (50) foot spacing.
8. Upstream from turning vanes.
9. Upstream or downstream from duct silencers.
10. Control devices requiring inspection.
11. Elsewhere as indicated.

I. Install access doors with swing against duct static pressure.

J. Access Door Sizes:

1. One-Hand or Inspection Access: Eight (8) inches by five (5) inches.
2. Two-Hand Access: Twelve (12) inches by six (6) inches.
3. Head and Hand Access: Eighteen (18) inches by ten (10) inches.
4. Head and Shoulders Access: twenty one (21) inches by fourteen (14) inches.
5. Body Access: Twenty five (25) inches by fourteen (14) inches.
6. Body plus Ladder Access: Twenty five (25) inches by seventeen (17) inches.

K. Label access doors according to Division 23 Specification Section "Identification for HVAC Systems and Equipment" to indicate the purpose of access door.

L. Install flexible connectors to connect ducts to equipment.

M. Connect equipment to supply ducts with maximum six (6) inch lengths of flexible duct. Do not use flexible ducts to change directions.

N. Connect flexible ducts to metal ducts with adhesive plus sheet metal screws.

O. Install duct test holes where required for testing and balancing purposes.

P. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of one quarter (1/4) inch movement during start and stop of fans.

3.11 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors and verify that purpose of access door can be performed.
3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation.
5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION 233113

## SECTION 23 34 23.08 – PROPELLER FANS

## PART 1 - GENERAL

1.1 SUMMARY

A. Section includes propeller wall fans, direct drive.

1.2 REFERENCE STANDARDS

A. Air Movement and Control Association International, Inc. (AMCA): www.amca.org:

1. AMCA Standard 204 - Balance Quality and Vibration Levels for Fans
2. AMCA Standard 205 - Energy Efficiency Classification for Fans
3. AMCA Standard 210 - ASHRAE 51 - Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating
4. AMCA Publication 211 - Certified Ratings Program - Product Rating Manual for Fan Air Performance
5. AMCA Standard 300 - Reverberant Room Method for Sound Testing of Fans
6. AMCA Publication 311 - Certified Ratings Program - Product Rating Manual For Fan Sound Performance

B. National Electrical Manufacturers Association (NEMA): www.nema.org

1. MG 1 – Motors and Generators

C. National Fire Protection Association (NFPA): www.nfpa.org:

1. NFPA 70 - National Electric Code

D. Underwriters Laboratories, Inc. (UL): www.ul.com:

1. UL 705 - Standard for Power Ventilators

1.3 ACTION SUBMITTALS

A. Product Data: Include the following:

1. Rated capacities and operating characteristics.
2. Fan Performance Data: Fan performance curves with flow, static pressure and horsepower.
3. Sound Performance Data: Fan sound power levels in eight octave bands and, A-weighted overall sound power level or sone values.
4. Motor ratings and electrical characteristics.
5. Furnished specialty components.
6. Specified accessories.

7. Dimensioned standard drawings indicating dimensions, weights, and attachments to other work.

1.4 INFORMATIONAL SUBMITTALS

A. Source quality-control reports.

B. Field quality-control reports.

C. ISO-9001 certificate.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Include routine maintenance, adjustment requirements, safety information, and troubleshooting guide.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: Approved ISO 9001-compliant manufacturer listed in this Section with minimum 10 years' experience in manufacture of similar products in successful use in similar applications, and with an ASME NQA-1 compliant Program.

1. Approval of Comparable Products: Submit the following in accordance with project substitution requirements, within time allowed for substitution review:

a. Product data, including certified independent test data indicating compliance with requirements.
b. Project references: Minimum of 5 installations not less than 5 years old, with Owner contact information.
c. Sample warranty.

2. Substitutions following award of contract are not allowed except as stipulated in Division 01 General Requirements.
3. Approved manufacturers must meet separate requirements of Submittals Article.

B. AMCA Compliance:

1. Provide fan types tested in accordance with AMCA Standard 210 (air performance) and AMCA Standard 300 (sound performance) in an AMCA-accredited laboratory.
2. Provide fan units rated according to AMCA Standard 211 (air performance) and AMCA Standard 311 (sound performance).
3. Provide fan units rated according to AMCA Standard 205 (fan efficiency grade).

1.7 COORDINATION

A. Coordinate sizes and locations of supports required for fan units.

B. Coordinate sizes and locations of equipment supports, roof curbs, and roof penetrations.

1.8 FIELD CONDITIONS

A. Handling and Storage: Handle and store fan units in accordance with manufacturer's published instructions. Examine units upon delivery for damage. Store units protected from weather.

1.9 WARRANTY

A. Manufacturer's Warranty: Manufacturer's standard form in which manufacturer agrees to furnish replacement components for fan units that demonstrate defects in workmanship or materials under normal use within warranty period specified.

1. Warranty Period: 12 months from startup or 18 months from shipment by manufacturer, whichever first occurs.

**PART 2 - PRODUCTS**

2.1 MANUFACTURER

A. Basis-of-Design Manufacturer: Provide fan units manufactured by **Twin City Fan & Blower**, Minneapolis MN; (763) 551-7600; email: tcf_sales@tcf.com; website: www.tcf.com.

B. Source Limitations: Obtain mixed flow fans from a single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Fan Performance Ratings: [Project site elevation-based] [Sea level elevation-based].

B. AMCA Seal: Provide units that bear the AMCA-Certified Ratings Seal.

C. Compliance:

1. Classified under AMCA Standard 205.
2. Provide units listed in accordance with UL/cUL 705.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70.

2.3 PROPELLER WALL FANS

A. Propeller Wall Fans: Medium duty direct-driven propeller wall fans for general-purpose ventilation.

1. Basis of Design Product: **Twin City Fan & Blower, Model WPD**.

2. Permanently attach nameplate displaying serial number and unit information.

B. Fan Capacities and Characteristics: Refer to Drawing schedule.

C. Propeller: [Cast aluminum blades in cast aluminum hub] [Painted steel blades welded to steel hub]. Hub secured to motor shaft with tapered bushing.

1. Statically and dynamically balance propeller.

D. Motors: Comply with NEMA MG-1 for designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 section "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
2. Motor Speed: 1,800 rpm.
3. Motor - Single Phase: Induction type, with split phase construction and capacitor start. [Open, Drip Proof (ODP)] [Totally Enclosed Fan Cooled (TEFC)] [Explosion Proof (EXP)] enclosure. Provide permanently lubricated heavy duty ball bearings.
4. Electrical Data:

    a. Voltage: 208 V; 1 phase; 3 wire, 60 Hz.

5. Provide unfused disconnect switch, NEMA 3R, selected in accordance with Division 26 section "Enclosed Switches."

    a. Ship disconnect switch loose for field mounting and wiring.
    b. Factory mount and wire disconnect switch.

E. Frame: Formed square tube steel supports bolted to steel panel with formed inlet venturi and pre-punched holes for mounting anchors. Motor mounting plate bolted to frame tubes.

F. Finish: Galvanized mill finish internal parts, and uncoated external aluminum and parts exposed to weather.
1. Enamel, Gray

G. Accessories:

1. Wall Box: 16 Ga galvanized steel, sized to match dimensions of fan panel, with mounting flange and pre-punched mounting holes. Suitable for attachment of inlet screen, backdraft damper, weather hood, outlet screen, damper guard, and disconnect switch.
2. Wall Collar: Galvanized steel, to match dimensions of fan mounting plate and wall thickness.

3. OSHA Motor Side Guard: Complies with OSHA standards by completely enclosing motor and drive components. Constructed of galvanized steel sides and galvanized wire screen.
4. Weather Hood: G90 galvanized steel hood to shield fan opening from snow and rain. Include bird screen of galvanized wire.
5. Damper Guard: Provide to protect backdraft damper from birds and debris. Include OSHA-compliant screen. Pre-punch mounting holes.
6. Backdraft Damper, Motorized, parallel-blade type. Adjust backdraft damper to close when fan is not running.

    a. Fabricate frame from galvanized steel.
    b. Fabricate blades from aluminum, mill finish, with vinyl edge seals.

7. Backdraft damper actuator suitable for 208 Vac, single phase.

8. Single Point Wiring: Provides a single location for making connections to the damper actuator and disconnect swtich.

9. Filter Box: Contains 2” thick aluminum washable filters.

H. Fan Capacities and Characteristics: Refer to Drawing schedule.

2.4 SOURCE QUALITY CONTROL

A. Certify sound-power level ratings according to AMCA Publication 311. Label fans with the AMCA-Certified Ratings Seal.

B. Certify fan performance ratings, including flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests according to AMCA 211. Label fans with the AMCA-Certified Ratings Seal.

2.5 SOURCE QUALITY CONTROL

A. Factory Run Test: Test run assembled fan units prior to shipment at specified operating speed or maximum RPM allowed. Statically and dynamically balance each wheel in accordance with ANSI/AMCA 204 "Balance Quality and Vibration Levels for Fans" to Fan Application Category BV-3, Balance Quality Grade G6.3. Obtain balance readings by electronic equipment in the axial, vertical, and horizontal directions on each set of bearings.

    1. Submit report of factory run test.

## PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive fans. Notify Engineer regarding conditions that may adversely affect installation, operation, or maintenance of fans. Proceed with installation once conditions are in accordance with manufacturer's published instructions.

3.2 PROTECTION

A. Protect adjacent construction and finished surfaces during installation and testing.

B. Except for operational testing, do not operate fan during construction.

3.3 INSTALLATION

A. Install fans in accordance with Contract documents and manufacturer's published instructions.

B. Install fan units with adequate clearances for service and maintenance.

C. Duct Connections: Drawings indicate general arrangement of ducts and duct accessories. Where indicated on Drawings, install factory-furnished companion flanges and make final duct connections with flexible connectors. Flexible connectors are specified in Division 23 section "Air Duct Accessories."

D. Electrical Connections: Connect wiring in accordance with NFPA 70 and Division 26 section "Low-Voltage Electrical Power Conductors and Cables."

1. Ground and bond equipment according to Division 26 section "Grounding and Bonding for Electrical Systems."

E. Equipment Identification: Label units according to Division 23 section "Identification for HVAC Piping and Equipment."

3.4 FIELD QUALITY CONTROL

A. Contractor shall retain qualified testing agency to perform field tests and inspections.

1. Verify that unit is secured to supports, and that duct and electrical connections are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
2. Verify that cleaning and adjusting are complete.
3. Verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.

4. Verify that manual and automatic volume control, and fire and smoke dampers in connected ductwork systems are in fully open position.
5. Disable automatic temperature-control actuators, energize motor, adjust fan to indicated rpm, and measure and record motor voltage and amperage.
6. Shut unit down and reconnect automatic temperature-control actuators.
7. Remove and replace malfunctioning units and retest as specified above.

B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Submit test and inspection reports.

3.5 ADJUSTING AND CLEANING

A. Adjust, clean, and maintain installed fan units in accordance with manufacturer's published instructions.

END OF SECTION

# SECTION 233423 – HVAC POWER VENTILATORS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 23.

### 1.2 SUMMARY

A. This section includes the requirements for centrifugal exhaust fans and power ventilators and accessories as follows:

1. Miscellaneous exhaust fans – Propeller and ceiling fans.

### 1.3 PERFORMANCE REQUIREMENTS

A. Project Altitude: Base fan performance ratings on actual project site elevations.

B. Operating Limits: Classify according to AMCA 99.

### 1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1. Include rated capacities, operating characteristics, and furnished specialties and accessories. Also include the following:

a. Certified fan performance curves with system operating conditions indicated.
b. Certified fan sound power ratings.
c. Motor ratings and electrical characteristics, plus motor and electrical accessories.
d. Material thickness and finishes, including color charts.
e. Dampers, including housings, linkages, and operators.
f. Fan speed controllers.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring.

C. Delegated Design Submittal: For unit hangars and supports indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
2. Design Calculations: Calculate requirements for selecting vibration isolators and for designing vibration isolation bases.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:

1. Roof framing and support members relative to duct penetrations.
2. Ceiling suspension assembly members.
3. Size and location of initial access modules for acoustical tile.
4. Ceiling mounted items including light fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

B. Field quality control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Include a copy of each approved submittal along with any applicable maintenance data in the project operation and maintenance manual.

B. Maintenance Material Submittals:

1. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
2. Belts: One (1) set(s) for each belt driven unit.

1.7 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. AMCA Compliance: Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal.

C. UL Standards: Power ventilators shall comply with UL 705. Power ventilators for use for restaurant kitchen exhaust shall also comply with UL 762.

1.8 SOURCE QUALITY CONTROL

A. Certify sound power level ratings according to AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Certify fan performance ratings, including flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating." Label fans with the AMCA Certified Ratings Seal.

1.9 COORDINATION

A. Coordinate size and location of structural steel support members.

B. Coordinate sizes and locations of concrete bases with actual equipment provided.

C. Coordinate sizes and locations of equipment supports, and roof penetrations with actual equipment provided.

1.10 WARRANTY/GUARENTEE

A. See Division 23 Specification Section “Basic Mechanical Requirements – HVAC” for warranty and guarantee requirements.

**PART 2 - PRODUCTS**

2.1 GENERAL PRODUCT REQUIREMENTS

A. Equipment Design and Selection: Exhaust air fans and power ventilators shall be designed and selected in accordance with the scheduled capacities on the drawings and the requirements of this specification. All fans shall bear the AMCA Seal, and fan ratings shall be based on test and procedures performed in accordance with AMCA Publication 211, AMCA Publication 311 and comply with the AMCA Certified Ratings Program and be UL and/or CUL listed.

B. Basis of Design: The basis of design for exhaust air fans and power ventilators shall be equipment manufactured by Twin City Fans as follows:

1. Miscellaneous Centrifugal Fans:
   a. Ceiling Mounted Fans – T Series
   b. Propeller Fans - WPD

C. Other Acceptable Manufacturers: Subject to compliance with requirements, provide exhaust air fans and power ventilators by one (1) of the following:
1. Miscellaneous Centrifugal Fans:

a. Propeller Fans: Greenheck, New York City Blower, Loren Cook, ACME
b. Ceiling Mounted Fans: Greenheck, New York City Blower, Loren Cook, ACME

D. Factory Run Test: Prior to shipment all fans shall be completely assembled and test run as a unit at operating speed or maximum RPM allowed for the particular construction type. Each wheel shall be statically and dynamically balanced in accordance with ANSI/AMCA 204-96 "Balance Quality and Vibration Levels for Fans" to Fan Application Category BV-3, Balance Quality Grade G6.3. Balance readings shall be taken by electronic type equipment in the axial, vertical and horizontal directions on each of the bearings. Records shall be maintained and a written copy shall be available upon request.

E. Motors: Motors shall comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Specification Section "Motor Requirements for HVAC Equipment."

2.2 MISCELLANOUS FANS

A. Propeller Fans: Propeller fans shall comply with the following:

1. Propeller Wall Fans: Medium duty direct-driven propeller wall fans for general-purpose ventilation.
2. Fan Capacities and characteristics: Refer to Drawing schedule.
3. Propeller: Painted steel blades welded to steel hub. Hub secured to motor shaft with tapered bushing.
   a. Statically and dynamically balance propeller.

4. Motors: Comply with NEMA MG-1 for designation, temperature rating, service factor, enclosure type, and efficiency requirements for motor specified in Division 23 section “Common Motor Requirements for HVAC Equipment.”
   a. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
   b. Motor Speed: 1,800 rpm.
   c. Motor – Single Phase: Induction type, with split phase construction and capacitor start. Open, Drip Proof (ODP) enclosure. Provide permanently lubricated heavy duty ball bearings.
   d. Motor – Three Phase: Induction type, with Open, Drip Proof (ODP) enclosure. Provide permanently lubricated heavy duty ball bearings.
   e. Provide unfused disconnect switch, NEMA 1, selected in accordance with Division 26 section “Enclosed Switches.”
      1) Ship disconnect switch loose for field mounting and wiring.
      2) Factory mount and wire disconnect switch.

f. Frame: Formed square tube steel supports bolted to steel panel with formed inlet venturi and pre-punched holes for mounted anchors. Motor mounted plate bolted to frame tubes.
g. Finish: Galvanized mill finish internal parts, and uncoated external galvanized steel parts exposed to weather.
h. Accessories:
   1) Wall Box: 16 Ga galvanized steel, sized to match dimensions of fan panel, with mounting flange and pre-punched mounting holes. Suitable for attachment of inlet screen, backdraft damper, weather hood, outlet screen, damper guard, and disconnect switch.
   2) Wall Collar: Galvanized steel, to match dimensions of fan mounting plate and wall thickness.
   3) OSHA Motor Side Guard: Complies with OSHA standards by completely enclosing motor and drive components. Constructed of galvanized steel sides and galvanized wire screen.
   4) Weather Hood: G90 galvanized steel hood to shield fan opening from snow and rain. Include bird screen of galvanized wire.
   5) Damper Guard: Provide to protect backdraft damper from birds and debris. Include OSHA-compliant screen. Pre-punch mounting holes.
   6) Backdraft Damper, Automatic, parallel-blade type. Adjust backdraft damper to close when fan is not running.
      a) Fabricate frame from galvanized steel.
   7) Single Point Wiring: Provides a single location for making connections to the disconnect switch.
   8) Filter Box: Contains 2” thick aluminum washable filters.

B. Ceiling Mounted Fans: Ceiling mounted fans shall comply with the following:
   1. The ceiling-mounted circulation fan is the model scheduled with the capacities indicated. The fan shall be furnished with standard mounting hardware and variable speed control to provide cooling and destratification. The fan speed control system is the model scheduled with the capacities indicated. The fan shall be furnished with a wall controller and upper temperature sensor to provide speed control of up to four (4) Powerfoil fans.
   2. Installation of the fan, miscellaneous or structural metal work (if required), field electrical wiring, cable, conduit, fuses and disconnect switches, other than those addressed in the installation scope of work, shall be provided by others. Factory installation services are available through Big Ass Fans. Consult the appropriate installation scope of work for information on the available factory installation options, overview of customer and installer responsibilities, and details on installation site requirements. Installation of the wall controller and upper temperature sensor, field electrical wiring, cable, conduit, fuses, and disconnect switches, other than those address in the installation scope of work, shall be provided by others. Factory installation services are available through Big Ass Fans. Consult the appropriate installation scope of work for information on the

available factory installation options, overview of customer and installer responsibilities, and details on installation site requirements.

3. Shop Drawings: Drawings detailing product dimensions, weight, and attachment methods. Product Data specification sheets on the ceiling-mounted fan and fan speed control system, specifying electrical and installation requirements, features and benefits, and controller information. File provided for architectural design. The manufacturer shall furnish a copy of all operating and maintenance instructions for the fans.
4. The entire fan assembly (without light kit) shall be Intertek/ETL-certified and builtpursuant to the construction guidelines set forth by UL standard 507 and CSA standard 22.2. Sustainability Characteristics: The fan shall be designed to move an effective amount of air for cooling and destratification in a variety of applications (including industrial and agricultural) over an extended life. The fan components shall be designed specifically for high volume, low speed fans to ensure lower operational noise. Sound levels from the fan operating at maximum speed measured in a laboratory setting shall not.
5. The onboard fan controller shall be constructed using a variable frequency drive (VFD) that is pre-wired to the motor and factory-programmed to minimize the starting and braking torques for smooth and efficient operation. The onboard controller shall be prewired to the motor using a short run of flexible conduit with a dedicated ground conductor to minimize electromagnetic interference (EMI) and radio frequency interference (RFI). A 15-ft incoming power cord shall be pre-wired to the controller with one of the following plugs: NEMA L6-20P Twist-Lock Plug, NEMA L6-30P Twist-Lock Plug, NEMA L15-20P Twist Lock Plug, NEMA L16-20P Twist-Lock Plug. As an option, the architect or owner may upgrade to the "harsh environment package," which includes a seal for the weather-resistant onboard VFD enclosure and a motor with IP55 NEMA classification. C. Airfoil System.
6. The fan shall be equipped with eight (8) Powerfoil airfoils of precision extruded aluminum alloy. The airfoils shall be connected by means of two (2) high strength locking bolts per airfoil. The airfoils shall be connected to the hub and interlocked with zinc plated steel retainers. The fan shall be equipped with eight (8) Powerfoil winglets on the ends of the airfoils and eight (8) AirFencesTM positioned on the airfoils at the optimum location for performance. Both the winglet and AirFence shall be molded of polypropylene. The standard color of the winglet and AirFence shall be "Safety Yellow." D. Motor.
7. The fan motor shall be an AC induction type inverter rated at one of the following:
   a. 1725 RPM, 200–240/400–480 VAC, 50/60 Hz, three-phase b. 1725 RPM, 575–600 VAC, 50/60 Hz, three-phase.
8. The motor shall be totally enclosed, fan cooled (TEFC) with an IP44 NEMA classification. A NEMA 56C standard frame shall be provided for ease of service. The motor shall be manufactured with a double baked Class F insulation and be capable of continuous operation in 32oF to 122oF (0oC to 50oC) ambient conditions. The motor shall have a C-face attachment that shall enable technicians

to detach the motor for easy field service. The C-face motor adapter shall be designed to work with the NitroSealTM gearbox. As an option, the architect or owner may upgrade to the "harsh environment package," which includes amotor with an IP55 NEMA classification. As part of the "harsh environment package," the onboard VFD enclosure is sealed for weather-resistant operation. E. Gearbox.

9. The fan gearbox shall be a NitroSealTM Drive designed specifically for the Powerfoil X series. The gearbox shall include a high-efficiency, hermetically sealed, nitrogen-filled, offset helical gear reducer with two-stage gearing, a hollow output shaft, cast iron housing, double lip seals, high quality SKF Explorer Series bearings with crowned cages for optimal lubrication flow, and precision machined gearing to maintain backlash less than 11 arc-minutes over the life of the unit. Lubrication shall be high-grade, low-foaming synthetic oil with extreme pressure additives and a wide temperature range. The gearbox shall be equipped with a hollow shaft threaded to accept a 3⁄4" NPT fitting in which wiring, piping, etc., can be routed to below the fan. A standard junction box can be affixed to this hollow shaft to allow for installing optional features such as lights or cameras. The inclusion of the hollow shaft shall be specified at the time of order. F. Mounting Post.
10. The fan shall be equipped with a mounting post that provides a structural connection between the fan assembly and extension tube. The mounting post shall be formed from A36 steel, contain no critical welds, and be powder coated for corrosion resistance and appearance.
11. The fan mounting system shall be designed for quick and secure installation on a variety of structural supports. The mounting yoke shall be of ASTM A-36 steel, welded construction, at least 3/16" thick, and powder coated for appearance and corrosion resistance. No mounting hardware or parts substitutions, including cast aluminum, are acceptable.
12. The fan hub shall be made of precision cut aluminum for high strength and light weight. The hub shall consist of two (2) aluminum plates, eight (8) aluminum spars and one (1) aluminum spacer fastened with a pin and collar rivet system. 2. The hub shall be secured to the output shaft of the gearbox by means of (10) high strength bolts. The hub shall incorporate five (5) safety retaining clips made of 1/4" (0.6 cm) thick steel that shall restrain the hub/airfoil assembly.
13. The fan shall be equipped with a safety cable that provides an additional means of securing the fan assembly to the building structure. The safety cable shall be Ø3/8" (1 cm) diameter and fabricated out of 7 x 19 galvanized steel cable. The end loops shall be secured with swaged Nicopress® sleeves, pre-loaded and tested to 3,200 lbf (13,345 N). Field construction of safety cables is not permitted.
14. The fan speed control system shall be compliant with NFPA 70-2011—National Electric Code (NEC). 2. Sustainability Characteristics: The system shall be designed to automatically control the speed of Big Ass Fans from the locations of the wall controller and upper temperature sensor to maximize energy savings and user comfort. The system shall be designed specifically for high volume, low speed Big Ass Fans, and receives information from user-determined settings and temperature sensors. Good workmanship shall be evident in all aspects of

installation. The wall control shall be a digital keypad device with an internal temperature sensor. It shall be wall-mounted centrally within the fan zone at head height using two (2) provided 6-32 x 7/8" pan head screws and four (4) provided 6-32 countersink. The wall controller shall be enclosed in a cast zinc cover measuring 3.86" (9.8 cm) x 7.25" (18.4 mm) x 1" (2.5cm) and be made of heavy-duty steel. The wall controller includes a Class II AC Adapter power cord. The wall controller only provides a speed reference for the fan. Start and stop functions are controlled by the auxiliary controller. The mounting location shall meet the requirements of OSHA standard 29 CFR 1910.303(g) for accessibility minimum clearances.

15. The upper temperature sensor shall be mounted in the upper portion of the fan zone either by using a provided I-Beam clamp, or by using four (4) provided mounting screws. The upper temperature sensor shall measure 1.9" (4.8 cm) x 4" (10.2 cm) x 1" (2.5 cm).
16. The fan shall be equipped with an auxiliary controller capable of providing 100% control of all fan functions. The auxiliary controller shall be a digital keypad device mounted within a cast zinc cover. The cover shall be capable of mounting to a standard switch box. The fan shall be equipped with touchpad controls and an LED display for controlling the fan's direction, operation, speed, and programming. Communication between the fan VFD and auxiliary controller is by a standard CAT5 (or higher) Ethernet cable. The auxiliary control comes standard with 150 ft of factory- assembled CAT5 Ethernet cable. The fan shall be equipped with a simple diagnostic program to identify faults in the system. Provisions shall be made for retrieving fan operation and diagnostic data (fault messages) through the auxiliary controller.
17. Includes a 10–30 VDC pilot relay for seamless fire control panel integration. The pilot relay can be wired Normally Open or Normally Closed in the field. Included for installations with extension tubes 4 ft (1.2 m) or longer to limit the potential for lateral movement.
18. The ceiling-mounted circulation fan is the model scheduled with the capacities indicated. The fan shall be furnished with mounting hardware, a remote control, and SenseMETM Technology as manufactured by Haiku® Home.
19. Installation of the fan, wireless network, miscellaneous or structural metal work (if required), field electrical wiring, cable, conduit, fuses and disconnect switches, other than those addressed in the installation scope of work, shall be provided by others. Installation services are available through Haiku Home. Consult the appropriate installation scope of work for information on the available installation options, overview of customer and installer responsibilities, and details on installation site requirements.
20. Shop Drawings: Drawings detailing product dimensions, weight, and attachment methods. Product Data Specification sheets on the ceiling-mounted fan, specifying electrical and installation requirements, features and benefits, and controller information Revit Files: Files provided for architectural design Product Documentation: The manufacturer shall furnish a copy of all installation, operation, and maintenance instructions for the fan.

21. The fan assembly, as a system, shall be Intertek/ETL-certified and built pursuant to relevant safety standards as described above. Sustainability Characteristics: The fan shall possess the ENERGY STAR Most Efficient 2015 designation. The fan shall display good workmanship in all aspects of its construction. Field balancing of the airfoils shall not be necessary.
22. Colors: Airfoil colors may be selected by the architect or owner as described in 2.2.C, "Airfoils." Optional Accessories:
    a. A wall-mounted controller (in addition to the standard remote control) may be selected at the time of order.
    b. An LED light may be selected at the time of order. c. Universal Mount fans: A 0–10 V module may be selected at the time of order. The module shall nable the fan to be integrated with a home or building automation system or a 3rd party 0–10 V dimmer using an industry-standard protocol.

C. Low Profile Mount
    1. The low profile mount shall be suitable for flat ceilings as low as 8 ft (2.4 m) tall. The fan shall be equipped with a mounting plate, rubber bumpers, mounting brackets, a compact low-profile motor hub assembly, and mounting hardware. The fan shall have a diameter of 60" (1.5 m).

D. Standard Mount
    1. The standard mount shall be suitable for flat ceilings with heights ranging from 8.5–12 ft (2.6–3.7 m). The fan shall be equipped with a rubber bushing, mounting bracket, wiring cover, wiring cover trim, standard motor hub assembly, and mounting hardware. c. The fan shall have a diameter of 60" (1.5 m).

E. Universal Mount
    1. The universal mount shall be suitable for flat or sloped ceilings with heights ranging from 8.5–18 ft (2.6–5.5 m). The fan shall be equipped with a mounting bracket, canopy, mounting ball and wedge, extension tubes, wiring cover, motor hub, and mounting hardware. A 7-inch (178-mm), 20-inch (508-mm), and 32-inch (813-mm) extension tube shall be included with the fan. The fan shall have a diameter of 60" (1.5 m).

F. The fan shall be equipped with three airfoils spanning a total diameter of 60 (1.5 m). Airfoils shall be made of glass composite.
    1. Airfoils shall be available in an automotive-grade black or white finish as specified by the architect or owner. Airfoils shall be damp-rated for use in covered outdoor spaces.

G. The fan shall have an electronically commutated motor (ECM) rated for 100–240 VAC, single-phase. The motor shall draw 1.39–31.27 watts depending on the speed at which the fan is operated and if a light is installed. The fan shall be designed for continuous operation in ambient temperatures of 32–104°F (0–40°C), and a humidity range of 20–90% (non-condensing). The fan's motor unit and motor unit trim shall be available in black or white as specified by the architect or owner.

H. The fan shall be equipped with a safety cable that provides an additional means of securing the fan assembly to the building structure. The safety cable shall be 1.5 mm in diameter and fabricated of aircraft steel. 2. Field construction of safety cables is not permitted.

I. The fan shall be equipped with SenseME Technology for smart automation, and shall be able to wirelessly connect to local Ethernet networks or host a network. The fan's Wi-Fi capability shall permit over-the-air firmware updates.

J. SenseME Technology control features shall be managed by users via the Haiku Home app. The Haiku Home app shall be supported by AndroidTM and iOS® mobile digital devices.

K. Haiku Home App Control Modes.
   1. Smart Mode. Alternates between seasonal settings—Smarter Heating and Smarter Cooling—to maintain comfort and maximize energy savings.
      a. Smarter Cooling. The user sets their ideal temperature, and the fan automatically adjusts to find the most comfortable fan speed.
      b. Smarter Heating. Automatically recirculates heat by increasing in speed when the user exits the room. When the user reenters the room, the fan slows.
      c. Smart Thermostat. Automatically signals the fan to switch from Smarter Cooling to Smarter Heating when a connected smart thermostat switches to Cooling or Heating Mode.
   2. Scheduling.
      a. Sets precise schedules for fan control modes.
   3. Whoosh® Mode.
      a. Silently varies fan speed to mimic cooling natural breezes.
   4. Sleep Mode.
      a. Responds to changing conditions to provide customized comfort all night long.
   5. Rooms.
      a. Enables users to group multiple fans in the same space for synchronized operation. Users shall be able to use the Haiku Home app or the optional Haiku Wall Control to automate fan and light functions or adjust settings manually
   6. Manual Speed Control.
      a. Speed settings range from 0 (Off) to 7 (High).
   7. Manual Light Control.
      a. The optional LED light has adjustable brightness and On and Off settings, as well as the ability to be controlled by the motion sensor and scheduling features. For fans with an LED light, see 2.2.H, "LED Light."

L. Haiku Home Account.
   1. Allows for integrated controls between fans and smart thermostats located on the same Wi-Fi network.

2. Sensors
   a. Motion sensor.
      1) The fan and light turn off or on to the last enabled speed or brightness when a person leaves or enters the room.
   b. Temperature and humidity sensor.
      1) The fan monitors room temperature and humidity in order to automatically adjust fan speed to reach the user's optimum thermal comfort level.
   c. Display and sound
      1) Changes to fan settings shall be confirmed with auditory feedback (a beep) and/or visual indication of the active setting.
      2) The fan mode indicators shall be located on the bottom of the fan and shall be visible from the floor. Indicators shall automatically turn off approximately five seconds after a setting is activated.
      3) Users shall have the ability to turn off the indicators and auditory feedback.
   d. Remote Control
      1) The fan shall be equipped with a compact IR remote control that allows intuitive operation of the fan in the following modes:
         a) Speeds 0 (Off) through 7 (High).
         b) Sleep Mode: Pressing the Sleep button on the remote shall activate the user's Haiku Home app Sleep settings or Wake Up settings.
         c) Timer Mode: In Timer Mode, the fan runs at a set speed until the programmed time period ends.
         d) Whoosh Mode: Silently varies fan speed to mimic cooling natural breezes.
      2) The remote shall control both the fan and light. Light brightness shall be increased or decreased by pressing the Up or Down Light button on the remote, and the light shall be turned on or off by pressing the Light On/Off button.
      3) Each operating mode shall be indicated by a pattern on the fan mode indicators, which shall be located on the bottom of the fan and shall be visible from the floor. All indicators shall automatically turn off approximately five seconds after the last control button is pressed.
      4) The remote shall be 1.2" wide x 3.4" tall x 0.2" thick (30 mm wide x 86 mm tall x 5 mm thick), and shall operate on a CR 2025 3 V lithium battery (included). H. LED Light (Optional).
3. The light kit shall include an LED light module, a diffused clear lens and a smoky lens, a lens trim, and mounting screws. The diffused clear lens shall be installed for maximum light emission. The smoky lens shall be installed for softer light emission. I. Haiku Wall Control (Optional)
4. The fan shall be equipped with a wireless Haiku Wall Control in addition to the standard remote control, as specified by the architect or owner. The Haiku Wall Control shall include temperature, humidity, and motion sensors. The user shall

be able to use the Haiku Home app to group the Haiku Wall Control with one or more fans for simultaneous control of fan speed, light brightness, and app features. The Haiku Wall Control buttons shall control both the fan and light (on/off and variable speed/brightness). J. 0–10 V Module (Optional, Universal Mount fans)

5. The fan shall be equipped with a 0–10 V module, as specified by the architect or owner. The module shall be compatible with Universal Mount fans. The module shall be installed in the fan's mounting bracket. The module shall provide independent control of fan speed and light intensity and shall support daisy chaining for one or up to 10 fans. The module shall be compatible with any 0–10 V sinking/sourcing dimmer and with most home or building automation systems.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of the work.

B. Examine roughing in for duct systems to verify actual locations of duct connections before fans are installed.

C. Examine foundations and inertia bases for suitable conditions where fans are to be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 FAN INSTALLATION

A. Refer to and follow fan manufacturers guidelines for rigging fans to their location.

B. Install fans level and plumb.

C. Install fans to provide access for periodic maintenance including removing motors, fan wheels, couplings, and accessories.

D. Independently support fans and ductwork so the weight of ductwork is not supported by the fans and weight of fans is not supported by the ductwork.

E. Vibration: Comply with requirements for seismic-restraint devices specified in Division 23 Specification Section "Vibration and Seismic Controls for HVAC Systems."

F. Label units according to requirements specified in Division 23 Specification Section "Identification for HVAC Systems and Equipment."

3.3 PREPARATION

A. Fan location shall have a typical bar joist or existing I-beam structure from which to mount the fan. Additional mounting options may be available.

B. Mounting structure shall be able to support weight and operational torque of fan. Consult structural engineer if necessary.

C. Fan location shall be free from obstacles such as lights, cables, or other building components.

D. Check fan location for proper electrical requirements. Consult installation guide for appropriate circuit requirements.

E. Each fan requires dedicated branch circuit protection.

F. Route power to within six (6) feet of the wall controller location. If additional distance is needed to power the wall controller, consult the alternative wiring method instructions in the Installation Guide. 3.2

G. The fan location must have an appropriate ceiling-mounted outlet box marked, "Acceptable for Fan Support." If there is not an appropriate outlet box already installed at the location, one must be installed on a ceiling joist or beam and be properly wired. Additional mounting options may be available. Consult the installation guide for additional details.

H. The fan location must be free from obstacles such as lights, cables, or other building components.

I. Check the fan location for proper electrical requirements. Consult the installation guide for appropriate circuit requirements.

3.4 INSTALLATION

A. The fan shall be installed by a factory-certified installer according to the manufacturer's Installation Guide, which includes acceptable structural dimensions and proper sizing and placement of angle iron for bar joist applications. Big Ass Fans recommends consulting a structural engineer for installation methods outside the manufacturer's recommendation and a certification, in the form of a stamped print or letter, submitted prior to installation.

B. Minimum Distances
   1. Airfoils shall be at least 10 ft (3 m) above the floor.
   2. Installation area shall be free of obstructions such as lights, cables, sprinklers or other building structures with the airfoils at least 2 ft (0.61 m) clear of all obstructions.

3. The structure the fan is attached to shall be capable of supporting a torque load of up to 300 ft·lb (407 N·m) of torque

C. The fan shall not be located where it will be continuously subjected to wind gusts or in close proximity to the outputs of HVAC systems or radiant heaters. Additional details are in the Big Ass Fans 3.2 Installation Manual.

D. In buildings equipped with sprinklers, including ESFR sprinklers, fan installation shall comply with all of the following:
   1. The maximum fan diameter shall be 24 ft (7.3 m).
   2. The HVLS fan shall be centered approximately between four adjacent sprinklers.
   3. The vertical clearance from the HVLS fan to the sprinkler deflector shall be a minimum of 3 ft (0.9 m).
   4. All HVLS fans shall be interlocked to shut down immediately upon receiving a waterflow signal from the alarm system in accordance with the requirements of NFPA 72 - National Fire Alarm and Signaling Code.

E. The wall control shall be installed by a factory-certified installer according to the Installation Guide.

F. The customer shall supply 2-conductor shielded cable (18-22AWG stranded) to connect the wall control components to the fan's variable frequency drive. The maximum distance between the wall controller and the upper temperature sensor shall be 1000 ft (305 m).

G. Installation areas must be free of obstructions such as lights, cables, sprinklers, or other building structures.

H. The components of the wall control shall not be mounted adjacent to or above radiant heaters, near HVAC ventilation intakes or exhausts, on poorly insulated exterior walls, in roof decking, or near radiant heat sources, and must be mounted so that they are exposed adequately to circulated air. Additional mounting guidelines can be found in the Installation Guide.

I. Install the fan according to the manufacturer's installation guide, which includes acceptable mounting methods.

J. Required Distances
   1. Airfoils must be at least 7 ft (2.1 m) above the floor.
   2. The airfoils must have at least 2 ft (0.6 m) clearance from all obstructions.
   3. The fan must be within a 30 ft (9.1 m) radius of where the mobile digital device will be used for control. (Line-of-sight obstructions may create a smaller maximum range.)
   4. The fan shall not be located where it will be subjected to rain or continuous wind gusts, or in close proximity to the outputs of HVAC systems or radiant heaters. Consult the installation guide for additional details.

K. Install and set up the Haiku Home app according to the manufacturer's instructions.

3.5 CONNECTIONS

A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23 Specification Section "HVAC Duct Systems and Accessories."

B. Ground equipment according to Division 26 Specification Section "Grounding and Bonding for Electrical Systems."

C. Connect wiring according to Division 26 Specification Section "Low Voltage Electrical Power Conductors and Cables."

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Verify that cleaning and adjusting are complete.
4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
5. Adjust belt tension.
6. Adjust damper linkages for proper damper operation.
7. Verify lubrication for bearings and other moving parts.
8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
9. Disable automatic temperature control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
10. Shut unit down and reconnect automatic temperature control operators.
11. Remove and replace malfunctioning units and retest as specified above.

C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Prepare test and inspection reports.

3.7 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Comply with requirements in Division 23 Specification Section "Testing, Adjusting, and Balancing HVAC Systems" for testing, adjusting, and balancing procedures.

D. Replace fan and motor pulleys as required to achieve design airflow.

E. Lubricate bearings.

END OF SECTION 233423

# SECTION 233600 – AIR DEVICES

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 23.

### 1.2 SUMMARY

A. This section includes the requirements for air terminal units and air devices as follows:

1. Square ceiling diffuser.
2. Perforated diffuser.
3. Adjustable bar register.
4. Fixed face register.
5. Perforated return/exhaust grille.
6. Egg crate return.

### 1.3 ACTION SUBMITTALS

A. Product Data: Provide product data for terminal units and air devices as follows:

1. Air Devices: Include:
   a. Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and sound-power ratings.
   b. Diffuser Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished

B. Shop Drawings: For air terminal units. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring.
3. Hangers and supports, including methods for duct and building attachment and vibration isolation.

### 1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Include a copy of each approved submittal along with any applicable maintenance data in the project operation and maintenance manual.

B. Maintenance Material Submittals:

1. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

a. Fan-Powered-Unit Filters: Furnish one spare filter(s) for each filter installed.

1.6 QUALITY ASSURANCE

A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."

1.7 WARRANTY/GUARANTEE

A. See Division 23 Specification Section “Basic Mechanical Requirements – HVAC” for warranty and guarantee requirements.

**PART 2 - PRODUCTS**

2.1 GENERAL PRODUCT REQUIREMENTS

A. Supply, Exhaust/Return Air Devices: Supply, exhaust/return air devices shall be tested in accordance with ANSI/ASHRAE Standard 70. Selections shall be based on performance characteristics that match or exceed those indicated on the drawings.

2.2 SUPPLY AIR DEVICES

A. Basis of Design: The basis of design for air devices is as follows:

1. Square Ceiling Diffusers: Titus Model – TDC, TDCA, PAS.
2. Adjustable Bar Register: Titus Model – 300, 301

B. Other Acceptable Manufacturers: Subject to compliance with requirements, provide air devices of one (1) of the following:

1. Price Industries
2. Metal Aire
3. Kruger
4. Envirotec
5. Carnes

6. Nailor

C. Square Ceiling Diffusers:
1. Material: Steel or Aluminum.
2. Module Size: twenty four (24) x twenty four (24).
3. Finish: Number twenty six (26) white baked enamel finish.
4. Face Style: Louvered.
5. Mounting: Snap in, Lay In, hard ceiling and/or Spline.
6. Pattern: One (1), two (2), three (3) or four (4) way blow as scheduled.
7. Dampers: opposed blade or butterfly damper with eight (8) inches of hard duct prior to damper.
8. Accessories: Throw reducing vanes.

D. Perforated Diffuser:

1. Material: Steel or aluminum frame and perforated face with three sixteenth (3/16) inch diameter holes on one quarter (1/4) inch staggered centers with a free area of not less than 51%.
2. Back Pan: One piece stamped steel pan.
3. Finish: Number twenty six (26) white baked enamel finish.
4. Duct Inlet: Round or Square.
5. Face Style: Flush.
6. Mounting: Surface T-bar Snap in Spline 4SL.
7. Pattern Controllers: Mounted on the back of the perforated face and be field adjustable.
8. Dampers: Opposed blade.
9. Accessories: Equalizing grid.

## 2.3 EXHAUST/RETURN AIR DEVICES

A. Basis of Design: The basis of design for air devices is as follows:

1. Adjustable Bar Register: Titus Model – 300, 301
2. Fixed Face Register: Titus Model – 350 R
3. Perforated Face Grille: Titus Model – PAR
4. Egg Crate Grilles: Titus Model – 50F

B. Other Acceptable Manufacturers: Subject to compliance with requirements, provide air devices of one (1) of the following:

1. Price Industries
2. Metal Aire
3. Kruger
4. Envirotec
5. Carnes

6. Nailor

C. Adjustable Bar Register:

1. Material: Steel Aluminum, Stainless steel.
2. Finish: Number twenty six (26) white baked enamel finish.
3. Face Blade Arrangement: Horizontal Vertical spaced three quarter (3/4) inch apart.
4. Core Construction: Integral.
5. Rear-Blade Arrangement: Horizontal Vertical spaced three quarter (3/4) inch apart.
6. Frame: One and one quarter (1-1/4) inches wide.
7. Mounting: Countersunk screw.
8. Damper Type: Adjustable opposed blade.
9. Accessories: Front Rear-blade gang operator.

D. Fixed Face Register:

1. Material: Steel, Aluminum, and Stainless Steel.
2. Finish: Number twenty six (26) white baked enamel finish.
3. Face Arrangement: Three quarter (3/4) inch spacing, deflection: 0. 35.
4. Core Construction: Integral.
5. Frame: One and one quarter (1-1/4) inches wide.
6. Mounting: Countersunk screw.
7. Damper Type: Adjustable opposed blade.

E. Perforated Return:

1. Face Material: Steel or aluminum perforated face with three sixteenth (3/16) inch diameter holes on one quarter (1/4) inch staggered centers with a free area of not less than 51%.
2. Back Pan: One piece stamped steel pan.
3. Finish: Number twenty six (26) white baked enamel finish.
4. Duct Inlet: Round or Square.
5. Face Style: Flush.
6. Mounting: Surface T-bar Snap in Spline 4SL.
7. Dampers: Opposed blade.
8. Accessories: Equalizing grid.

F. Egg Crate Return:

1. Material - Shell: Heavy gauge extruded aluminum, 0.040-0.050 inches thick with countersunk screw holes.
2. Grid: Aluminum grid with three (3) sizes available: <Edit for Project>

    a. One half (1/2) inch x one half (1/2) inch x one half (1/2) inch.

b. One half (1/2) inch x one half (1/2) inch x one (1) inch.
c. One (1) inch x one (1) inch x one (1) inch.

3. Minimum Free Area: The minimum free area must be not less than 90% free area.
4. Border Types: Surface mount, or Lay in type.
5. Accessories: Opposed blade damper.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install diffusers, registers, and grilles level and plumb with the ceiling and or wall surface.

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

### 3.2 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

### 3.3 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes and for slabs more than four (4) inches thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes and for slabs less than four (4) inches thick.

C. Hangers Exposed to View: Threaded rod and angle or channel supports.

D. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

E. Trapeze and Riser Supports: Steel shapes and plates for units with steel casings; aluminum for units with aluminum casings.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

END OF SECTION 233600

# SECTION 237313 – MODULAR CENTRAL STATION AIR HANDLING UNITS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 23.

### 1.2 SUMMARY

A. This section includes the requirements for modular indoor central station air handling units as follows:
   1. Unit casings.
   2. Fans, drives and motors.
   3. Coil selections.
   4. Air filtration.
   5. Dampers and filter mixing sections.

B. General Description: Factory assembled, consisting of fans, motor and drive assembly, coils, damper, plenums, filters, drip pans, and mixing dampers, etc.

### 1.3 PERFORMANCE REQUIREMENTS

A. Structural Performance: Casing panels shall be self supporting and capable of withstanding 133% of internal static pressures indicated, without panel joints exceeding a deflection of L/200 where "L" is the unsupported span length within completed casings.

### 1.4 ACTION SUBMITTALS

A. Product Data: For each air handling unit indicated.

   1. Unit dimensions and weight.
   2. Cabinet material, metal thickness, finishes, insulation, and accessories.
   3. Fans:

      a. Certified fan performance curves with system operating conditions indicated.
      b. Certified fan sound power ratings.
      c. Fan construction and accessories.
      d. Motor ratings, electrical characteristics, and motor accessories.

   4. Certified coil performance ratings with system operating conditions indicated.
   5. Dampers, including housings, linkages, pressure drop data and operators.
   6. Filters with performance characteristics, including pressure drop data.

B. Delegated Design Submittal: For vibration isolation indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
2. Design Calculations: Calculate requirements for selecting vibration isolators and for designing vibration isolation bases.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Mechanical room layout and relationships between components and adjacent structural and mechanical elements.
2. Support location, type, and weight.
3. Field measurements.

B. Source quality control reports.

C. Field quality control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Include a copy of the final approved submittal for each product in the operation and maintenance manuals.

B. Maintenance Material Submittals:
1. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

a. Filters: One set(s) for each air handling unit.
b. Gaskets: One set(s) for each access door.
c. Fan Belts: One set(s) for each air handling unit fan.

1.7 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.

C. ARI Certification: Air handling units and their components shall be factory tested according to ARI 430, "Central-Station Air Handling Units," and shall be listed and labeled by ARI.

D. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

E. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air Conditioning."

F. Comply with NFPA 70.

1.8 QUALITY CONTROL

A. Fan Sound Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Fans shall bear AMCA-certified sound ratings seal.

B. Fan Performance Rating: Factory test fan performance for airflow, pressure, power, air density, rotation speed, and efficiency. Rate performance according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating."

C. Water Coils: Factory tested to 300 psig according to ARI 410 and ASHRAE 33.

1.9 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

B. Coordinate sizes and locations of structural steel support members, if any, with actual equipment provided.

1.10 WARRANTY/GUARANTEE

A. See Division 23 Specification Section “Basic Mechanical Requirements – HVAC” for warranty and guarantee requirements.

**PART 2 - PRODUCTS**

2.1 GENERAL PRODUCT REQUIREMENTS

A. Equipment Design and Selection: Modular indoor central station air handling units shall be designed and selected, for the intended use, in accordance with the scheduled capacities on the drawings and the requirements of this specification.

B. Manufacturers:

C. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. Daikin, Vision
2. Air Enterprises, Inc.
3. Munters
4. Annexair

2.2 INDOOR AIR HANDLING UNIT

A. Delivery, Storage, and Handling
1. Deliver, store, protect and handle products to site.
2. Accept products on site on factory-furnished shipping skids. Inspect for damage.
3. Store in clean dry place and protect from construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

B. Unit Construction
1. Fabricate unit with heavy gauge channel posts and panels secured with mechanical fasteners. All panels, access doors, and ship sections shall be sealed with permanently applied bulb-type gasket. Shipped loose gasketing is not allowed.
2. Panels and access doors shall be constructed as a 2-inch nominal thick; thermal broke double wall assembly, injected with foam insulation with an R-value of not less than R-13.
   a. The inner liner shall be constructed of G90 galvanized steel.
   b. The outer panel shall be constructed of G90 galvanized steel.
   c. The floor plate shall be constructed as specified for the inner liner.
   d. Unit will be furnished with solid inner liners.
3. Panel deflection shall not exceed L/240 ratio at 125% of design static pressure, maximum 5 inches of positive or 6 inches of negative static pressure. Deflection shall be measured at the panel midpoint.
4. The casing leakage rate shall not exceed 0.50 cfm per square foot of casing surface area at design static pressure up to a maximum of +5” w.c. in positive pressure sections and -6” w.c. in negative pressure sections (.0025 m3/s per square meter of cabinet area at 1.24 kPa static pressure)
5. Module to module field assembly shall be accomplished with an overlapping, full perimeter internal splice joint that is sealed with bulb type gasketing on both mating modules to minimize on-site labor and meet indoor air quality standards.
6. Access doors shall be flush mounted to cabinetry, with minimum of two six inch long stainless steel pianotype hinges, latch and full size handle assembly. Access doors shall swing outward for unit sections under negative pressure. Access doors on positive pressure sections, shall have a secondary latch to relieve pressure and prevent injury upon access.
7. A 6-inch formed G60 galvanized steel base rail shall be provided by the unit manufacturer for structural rigidity and condensate trapping.. The base rail shall

be constructed with 12-gauge nominal for unit sizes 003 - 035 and 10-gauge nominal for unit sizes 040 - 090. The following calculation shall determine the required height of the baserail to allow for adequate drainage. Use the largest pressure to determine base rail height. [(Negative)(Positive) static pressure (in)] (2) + 4" = required baserail height. Should the unit baserail not be factory supplied at this height, the contractor is required to supply a concrete housekeeping pad to make up the difference.

8. Construct drain pans from stainless steel with cross break and double sloping pitch to drain connection. Provide drain pans under cooling coil section. Drain connection centerline shall be a minimum of 3'' above the base rail to aid in proper condensate trapping. Drain connections that protrude from the base rail are not acceptable. There must be a full 2'' thickness of insulation under drain pan.

C. Fan Assemblies
   1. Acceptable fan assembly shall be a double width, double inlet, class II, belt-drive type housed forward curved fan dynamically balanced as an assembly, as shown in schedule. Maximum fan RPM shall be below first critical fan speed. Fan assemblies shall be dynamically balanced by the manufacturer on all three planes and at all bearing supports. Copper lubrication lines shall be provided and extend from the bearings and attached with grease fittings to the fan base assembly near access door. If not supplied at the factory, contractor shall mount copper lube lines in the field. Fan and motor shall be mounted internally on a steel base. Provide access to motor, drive, and bearings through hinged access door.
   2. Fan and motor shall be mounted internally on a steel base. Factory mount motor on slide base that can be slid out the side of the unit if removal is required. Provide access to motor, drive, and bearings through hinged access door. Fan and motor assembly shall be mounted on 2" deflection spring vibration type isolators inside cabinetry.

D. Bearings, Shafts, and Drives
   1. Bearings: Basic load rating computed in accordance with AFBMA - ANSI Standards. The bearings shall be designed for service with an L-50 life of 200,000 hours and shall be a heavy duty pillow block, self-aligning, grease-lubricated ball or spherical roller bearing type.
   2. Shafts shall be solid, hot rolled steel, ground and polished, keyed to shaft, and protectively coated with lubricating oil. Hollow shafts are not acceptable.
   3. V-Belt drives shall be cast iron or steel sheaves, dynamically balanced, bored to fit shafts and keyed. Fixed sheaves, matched belts, and drive rated based on motor horsepower. Minimum of 2 belts shall be provided on all fans with 10 HP motors and above. Standard drive service factor minimum shall be 1.1 S.F. for 1/4 HP – 7.5 HP, 1.3 S.F. for 10 HP and larger, calculated based on fan brake horsepower.

E. Electrical

1. Fan motors shall be manufacturer provided and installed, Open Drip Proof, premium efficiency (meets or exceeds EPAct requirements), 1750 RPM, single speed, 460V / 60HZ / 3P. Complete electrical characteristics for each fan motor shall be as shown in schedule.
2. The air handler(s) shall be ETL and ETL-Canada listed by Intertek Testing Services, Inc. Units shall conform to bi-national standard ANSI/UL Standard 1995/CSA Standard C22.2 No. 236.
3. Wiring Termination: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclosed terminal lugs in terminal box sized to NFPA 70.
4. Manufacturer shall provide ASHRAE 90.1 Energy Efficiency equation details for individual equipment to assist Building Engineer for calculating system compliance.
5. Installing contractor shall provide GFI receptacle within 25 feet of unit to satisfy National Electrical Code requirements.
6. All electrical connection components shall be field provided and mounted as shown on project schedule.

F. Cooling and Heating Coils
1. Certification – Acceptable refrigerant coils are to be verified in accordance with AHRI Standard 410 and bear the AHRI label. Coils exceeding the scope of the manufacturer's certification and/or the range of AHRI's Standard rating conditions will be considered provided the manufacturer is a current member of the AHRI Air-Cooling and Air-Heating Coils certification programs and that the coils have been rated in accordance with AHRI Standard 410. Manufacturer must be ISO 9002 certified.
2. Water Refrigerant coil shall be provided. Provide access to coil(s) for service and cleaning. Enclose coil headers and return bends fully within unit casing. Unit shall be provided with coil connections that extend a minimum of 5" beyond unit casing for ease of installation. Drain and vent connections shall be provided exterior to unit casing. Coil connections must be factory sealed with grommets on interior and exterior panel liners to minimize air leakage and condensation inside panel assembly. If not factory packaged, Contractor must supply all coil connection grommets and sleeves. Coils shall be removable through side and/or top panels of unit without the need to remove and disassemble the entire section from the unit.
    a. Coils designed for use with Refrigerant R410a. Fins shall have a minimum thickness of 0.0075 of aluminum plate construction with full drawn collars to provide a continuous surface cover over the entire tube for maximum heat transfer. Tubes shall be mechanically expanded into the fins to provide a continuous primary-to-secondary compression bond over the entire finned length for maximum heat transfer rates. Bare copper tube shall not be visible between fins.

b. Refrigerant coils shall be provided with round seamless 5/8" O.D. copper tubes on 1-1/2" centers, staggered in the direction of airflow. All joints shall be brazed.
c. Sweat type copper suction connections located at the bottom of the suction headers for gravity oil drainage. Coils shall be uniformly circuited in a counterflow manner for single circuit capacity reduction. Pressure type liquid distributors used. Coils shall be tested with 315 pounds air pressure under warm water, and suitable for 250 psig working pressure.

3. Electrical Heating:
   a. ETL-approved electrical heaters for horizontal-mounted draw through units in both left and right hand configurations. All units are open wire style construction, with automatic and manual backup limit controls, air switch, stainless steel terminals, power on pilot light, magnetic contractors and integral control boxes. Safety interlock switches, step controllers and Vernier silicon controlled rectifiers. (SCRs).
   b. The heater requires its own electrical service. Heaters are available in 208V, 240V, 480V and 600V (all 3 phase) and use internal 24-volt control circuit.
   c. An integral control box with door handle power disconnect is included with the electrical heater. Insulated panels are factory installed behind the control box.

2.3 FILTERS

A. Furnish flat panel filter section with 2-inch pleated MERV 8 filter. Provide side loading and removal of filters.

B. Filter media shall be UL 900 listed, Class I or Class II.

C. Filter Magnehelic gauge(s) shall be furnished and mounted by others.

2.4 ADDITIONAL SECTIONS

A. Mixing box section shall be provided with end outside air opening and top return air opening with or without parallel low leak airfoil damper blades. Dampers shall be hollow core galvanized steel airfoil blades, fully gasketed and have continuous vinyl seals between damper blades in a galvanized steel frame. Dampers shall have stainless steel jamb seals along end of dampers. Connecting linkage and ABS plastic end caps shall be provided when return and outside air dampers are each sized for full airflow. Return and outside air dampers of different sizes must be driven separately. Damper Leakage: Leakage rate shall be less than two tenths of one percent leakage at 2 inches static pressure differential. Leakage rate tested in accordance with AMCA Standard 500.

2.5 Outdoor Condensing Unit

A. Unit Description: Scroll Option Provide and install, as shown on the plans, a factory-assembled, air-cooled scroll compressor condensing units in the size and quantity

specified. Each unit shall consist of hermetic tandem or triple scroll compressor sets, air cooled condenser section. Design Requirements: Provide a complete condensing unit as specified herein and as shown on the drawings. Refer to schedule of performance on the drawings. Performance shall be in accordance with ARI Standard 365-94.

B. Condensing Section
   1. Air Cooled Condenser
      a. Each condenser coil shall be factory leak tested with high-pressure are under water. Each refrigerant circuit shall provide 15 degrees of liquid subcooling.
      b. Condenser coils shall be fabricated from cast aluminum micro-channel coils. Each condenser coil shall be factory leak tested with high-pressure air under water. Coils are to be recessed so that the cabinet provides built in hail protection.
      c. Condenser fans shall be 1140 rpm direct drive., propeller type designed for low tip speed, vertical air discharge and include service guards. Fan blades shall be constructed of steel and riveted to a steel center hub. Condenser fan motors shall be heavy-duty, inherently protected, three phase, non-reversing type with permanently lubricated ball bearing and integral rain shield.
      d. Units shall have at least one condenser fan controlled to maintain positive head pressure. An ambient thermostat shall prevent the refrigeration system from operating below 45°F ambient.
   2. Scroll Compressors
      a. Unit shall have multiple, heavy duty Copeland scroll compressors.
      b. Each compressor shall be complete with gauge ports, oil sight glass, crank case heater, anti-slug protection, and a time delay to prevent short cycling and simultaneous starting of compressors following power failure.
      c. Compressors shall be isolated with resilient rubber isolators to decrease noise transmission.
      d. Refrigeration capacity control shall be accomplished by staging of the units multiple compressors. Liquid tight conduit shall be provided on exposed compressor wire.
      e. Each compressor shall have motor temperature sensing and current sensing overload protection.
   3. Refrigerant Circuit: Manual chagrining/ evacuation valve and capped connections shall be provided for field connection of refrigerant piping.
      a. Refrigerant specialties shall be field supplied and installed.
      b. The unit shall have two independent refrigeration circuits.

C. Controls
   1. Unit shall be equipped with a low pressure and high pressure safetly for each refrigerant circuit.
   2. Unit manufacturer shall provide necessary relays for cooling stages as stated on equipment schedule.
   3. Field powered 115V outlet.

D. Accessories
   1. Hot gas bypass kit for one circuit to allow unit operation to 10 percent of full load.
   2. VFD condenser fan speed control shall be added to the last fan off on each refrigeration circuit to provide cooling operation to ambient temperatures down to 0°F.
   3. Unit shall be equipped with a 24 V terminal strip for field supplied and installed controls.
   4. Non-fused disconnect switch with through-the-door handle.
   5. ElectroFin baked epoxy coating providing 3000+ hour salt spray resistance (ASTM B117-90) and is applied to both the coil and the coil frames.
   6. Spring vibration isolators for field installation.
   7. Vandal guards.
   8. Factory powered 115 V convenience outlet.
   9. The manufacturer will provide extended 48 month, parts only, warranty on the compressor.
   10. The condensing unit shall be designed, manufactured, and independently tested, rated, and certified to meet the seismic standards of the 2009 International Building Code and ASCE 7-06.
      a. Certificates of Compliance shall be provided with the quotation and include the manufacturer's identification, designation of certified characteristics, and the Independent Certifying Agency's name and report identification.
      b. Clear installation instructions shall be provided including all accessory components.
   11. Suction and discharge isolation valves for each refrigeration circuit.

2.6 Indoor Air Handling Unit ( Chilled Water Coils)

A. Equipment Design and Selection: Modular indoor central station air handling units shall be designed and selected, for the intended use, in accordance with the scheduled capacities on the drawings and the requirements of this specification.

B. Manufacturers:

C. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

   1. Carrier Corporation; a member of the United Technologies Corporation Family.
   2. McQuay International
   3. Trane; American Standard Inc.
   4. YORK International Corporation.
   5. PETRA (Basis of Design)

2.7 UNIT CASINGS

A. General Fabrication Requirements for Casings: Comply with the following:

1. Forming: Form walls, roofs, and floors with at least two (2) breaks at each joint.
2. Medium and high pressure units shall be constructed with additional bracing and supports. Units rated at 5.5 inches wg and higher shall be connected to accessories sections with double thickness neoprene coated flexible connection.
3. Casing Joints: Sheet metal screws or pop rivets.
4. Sealing: Seal all joints with water resistant sealant.
5. Factory Finish for Galvanized Steel Casings: Apply manufacturer's standard primer immediately after cleaning and pretreating.
6. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

B. Casing Insulation and Adhesive: Comply with the following:

1. Materials: ASTM C 1071, Type II.
2. Location and Application: Factory applied with adhesive and mechanical fasteners to the internal surface of section panels downstream from, and including, the cooling-coil section.

    a. Liner Adhesive: Comply with ASTM C 916, Type I.
    b. Mechanical Fasteners: Mechanical fasteners shall be galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
    c. Liner Materials: Liner materials applied in this location shall have air-stream surface coated with a temperature resistant coating or faced with a plain or coated fibrous mat or fabric depending on service air velocity.

3. Location and Application: Encased between outside and inside casing.

C. Inspection and Access Panels and Access Doors: Comply with the following:

1. Panel and Door Fabrication: Panels and doors shall be formed and reinforced, single wall or double wall and insulated panels of same materials and thicknesses as casing.
2. Inspection and Access Panels:

    a. Fasteners: Provide two (2) or more camlock type for panel lift out operation. Arrangement shall allow panels to be opened against air pressure differential.
    b. Gasket: Neoprene gaskets shall be applied around entire perimeters of panel frames.
    c. Size: Large enough to allow inspection and maintenance of air handling unit's internal components.

3. Access Doors: Comply with the following:

    a. Hinges: Provide a minimum of two (2) ball-bearing hinges or stainless steel piano hinge and two (2) wedge lever type latches, operable from inside and outside. Arrange doors to be opened against air pressure differential.
    b. Gasket: Neoprene gaskets shall be applied around entire perimeters of panel frames.

4. Locations and Applications: Comply with the following:

    a. Fan Section: Doors.
    b. Access Section: Doors.
    c. Coil Section: Inspection and access panel.
    d. Damper Section: Inspection and access panels.
    e. Filter Section: Doors large enough to allow periodic removal and installation of filters.
    f. Mixing Section: Doors.

D. Condensate Drain Pans: Comply with the following:

1. Slope: Drain pans shall be fabricated with 1% slope in at least two (2) planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and from humidifiers and to direct water toward drain connection.
2. Single-wall, stainless steel sheet.
3. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one (1) end of pan.

    a. Minimum Connection Size: NPS 1.

4. Pan-Top Surface Coating: Surface coating shall be asphaltic waterproofing compound.
5. Intermediate Drain Pan - Stacked Coils: Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.

E. Air Handling Unit Mounting Frame: Provide formed galvanized steel channel or structural channel supports, designed for low deflection, and welded with integral lifting lugs.

1. Seismic Fabrication Requirements: Fabricate mounting base and attachment to air-handling unit sections, accessories, and components with reinforcement strong enough to withstand seismic forces defined in Division 23 Specification Section "Vibration and Seismic Controls for HVAC Systems" when air handling unit frame is anchored to building structure.

2.8 FAN, DRIVE, AND MOTOR SECTION

A. General: Sound power level ratings shall comply with AMCA Standard 301 "Method for Calculating Fan Sound Ratings from Laboratory Test Data" and shall be the result of tests made in accordance with AMCA standard 300 "Test Code for Sound Rating" Fans shall be licensed to bear the AMCA Certified Sound Ratings Seal.

B. Fan Performance Rating: Unit's fans performance ratings for flow rate, pressure, power, air density, speed or rotation, and efficiency shall be factory tested and ratings established in accordance with AMCA Standard 210/ASHRAE Standard 51 – Laboratory Methods of Testing Fans for Rating.

C. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum rated fan speed and motor horsepower.

1. Shafts: Shafts shall be designed for continuous operation at maximum rated fan speed and motor horsepower, and with field adjustable alignment.

a. Turned, ground, and polished hot rolled steel with keyway. Ship with a protective coating of lubricating oil.
b. Designed to operate at no more than 70% of first critical speed at top of fan's speed range.

D. Centrifugal Fan Housings: Housings shall be formed and reinforced steel panels to form curved scroll housings with shaped cutoff and spun-metal inlet bell.

1. Bracing: Provide steel angle or channel supports for mounting and supporting fan scroll, wheel, motor, and accessories.
2. Horizontal Flanged, Split Housing: Bolted construction.
3. Housing for Supply Fan: Attach housing to fan section casing with metal-edged flexible duct connector.
4. Flexible Connector: Factory fabricated with a fabric strip 3-1/2 inches wide attached to two (2) strips of 2-3/4 inch wide, 0.028 inch thick, galvanized steel sheet or 0.032 inch thick aluminum sheets; select metal compatible with casing.
   a. Flexible Connector Fabric: Glass fabric, double coated with neoprene. Fabrics, coatings, and adhesives shall comply with UL 181, Class 1.

      1) Fabric Minimum Weight: 26 oz./sq. yd..
      2) Fabric Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
      3) Fabric Service Temperature: - 40°F to + 200°F.

E. Plenum Fan Housings: Steel frame and panel; fabricated without fan scroll and volute housing.

F. Fan Wheels: Fan wheels shall be as follows:

1. Forward Curved, Centrifugal Fan Wheels: Inlet flange, backplate, and shallow blades with inlet and tip curved forward in direction of airflow and mechanically fastened to flange and backplate; cast steel hub swaged to backplate and fastened to shaft with set screws.

G. Fan Shaft Bearings: Comply with the following:

1. Grease Lubricated Bearings: Self aligning, pillow block type, ball or roller bearings with adapter mount and two (2) piece, cast iron housing with grease lines extended to outside unit.

H. Belt Drives: Factory mounted, with adjustable alignment and belt tensioning, and with 1.4 service factor based on fan motor.

1. Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
2. Motor Pulleys: Adjustable pitch for use with 15 hp motors and smaller; fixed pitch for use with motors larger than 15 hp. Select pulley size so pitch adjustment is at the middle of adjustment range at fan design conditions.
3. Belts: Oil resistant, nonsparking, and nonstatic; in matched sets for multiple belt drives.
4. Belt Guards: Comply with requirements specified by OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards"; 0.1046 inch thick, three quarter (3/4) inch diamond-mesh wire screen, welded to steel angle frame; prime coated.

I. Discharge Dampers: Heavy duty steel assembly with channel frame and sealed ball bearings, and opposed blades constructed of two (2) plates formed around and welded to shaft, with blades linked out of air stream to single control lever.

J. Motor: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Specification Section "Motor Requirements for HVAC Equipment."

1. NEMA Premium (TM) efficient motors as defined in NEMA MG 1.
2. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
3. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
4. Mount unit mounted disconnect switches on interior of unit.

K. Variable Frequency Drives See Division 26 Specification Section “Variable Frequency Drives” for requirements.

2.9 COIL SECTION

A. General Requirements for Coil Section: Comply with the following:

1. Comply with ARI 410.
2. Fabricate coil section to allow removal and replacement of coil for maintenance and to allow in place access for service and maintenance of coil(s).
3. For multizone units, provide air deflectors and air baffles to balance airflow across coils.
4. Coils shall not act as structural component of unit.
5. Seismic Fabrication Requirements: Fabricate coil section, internal mounting frame and attachment to coils, and other coil section components with reinforcement strong enough to withstand seismic forces defined in Division 23 Specification Section "Vibration and Seismic Controls for HVAC Systems" when coil mounting frame and air handling unit mounting frame are anchored to building structure.

B. Coils, General: Drainable, rigidly supported across the full face of the coil, and pitched to allow drainage.

1. Fins: Aluminum or copper, constructed form flat plate with belled collars for tubes. Fins shall be bonded to tubes by mechanically expanding copper tubes.
2. Tubes: Seamless copper.
3. Coil Casing: Galvanized steel.
4. Headers for Water Coils: Steel or cast iron, with connections for drain valve and air vent and threaded piping connections.

2.10 AIR FILTRATION SECTION

A. General Requirements for Air Filtration Section: Comply with the following:

1. Comply with NFPA 90A.
2. Provide minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
3. Provide filter holding frames arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.
4. Spare Filters: Provide two (2) sets of spare filters for each type of filter media. One (1) set of spare of filters shall be installed in the air handling unit for the testing and balancing procedure. The second set of spare filter media shall be turned over to the owner.
5. Air Handling Unit Operation during Construction: When the air handling units need to be operated during construction the contractor shall provide the filters for the air handling unit. These filters shall be separate from the specified filter media. Install specified filter media prior to final test and balance of air handling systems.

B. Filter Types: Comply with the following:

1. Disposable Pre Filter Media:

Filter Media: Filter media shall have an average efficiency of 25% to 30% and an average arrestance of 90% to 92% in accordance with ASHRAE Test Standard 52.2.

1) Two (2) inch Filter: Filter faced area shall contain not less than 15 pleats per linear foot. Initial resistance at 500 fpm shall not exceed .28 inch wg.

b. Media Support Grid: Grid shall be welded wire on one (1) inch centers with an open area of not less than 96%. Grid shall be bonded to the media to eliminate oscillation and pull away. The grid shall be formed to affect a radial pleat, allowing total use of media.

1) Enclosing Frame: The frame shall be a rigid, high wet-strength beverage board, with diagonal support members bonded to the air entering and exiting side of each pleat. The enclosing frame shall be chemically bonded to the filter pack.

c. Final Filter Media – Pleated Type:

1) Air filters shall be high performance, deep pleated, totally rigid and totally disposable type. Each filter shall consit of high density media, media support grid, contour stabilizers, diagonal support bracing and enclosing frame.
a) 90% to 95% Efficient – Filter media shall be of high density micro fine glass fibers, laminated to a reinforcing backing to form a lofted filter blanket. The filter media shall have an average efficiency of 90-95% on ASHRAE Test Standard 52.2). It shall have an average arrestance3 of not less than 99% on that standard. Filters shall be listed by Underwriters' Laboratories as Class (2) (1).

2) Media Support Grid – The media support shall be a welded wire gird with an effective open area of not less than 96%. The welded wire grid shall be bonded to the filter media to eliminate the possibility of media oscillation and media pull away. The media support gird shall be formed in such a manner that it affects tapered radial pleat design. The grid shall be designed to support the media both vertically and horizontally.

3) Contour Stabilizers – Contour stabilizers shall be galvanized steel and shall be permanently installed on both the air entering and air exiting sides of the filter media pack to insure that the tapered radial pleat configuration is maintained throughout the life of the filter. There shall be four contour stabilizers on the air entering side and six on the air exiting side. The filter shall be capable of withstanding 10 inch wg. pressure drop without noticeable distortion of the media pack.

4) Enclosing Frame – The enclosing frame shall be constructed of galvanized steel. It shall be assembled in such a manner that a rigid and durable enclosure for the filter pack is affected. The media pack shall be mechanically and chemically bonded to the inside of the periphery of the enclosing frame, thus eliminating the possibility of air by-pass. The enclosing frame shall be equipped with galvanized steel protective diagonal support braces on both the air entering and air exiting sides of the filers. The diagonal support braces shall be mechanically fastened to each contour stabilizer.

## 2.11 DAMPERS AND COMBINATION FILTER MIXING SECTION

A. General Requirements for Dampers: Leakage rate, according to AMCA 500, "Laboratory Methods for Testing Dampers for Rating," shall not exceed 2% of air quantity at two thousand (2,000) fpm face velocity through damper and four (4) inch wg pressure differential.

B. Damper Operators: Comply with requirements in Division 23 Specification Sections for "Building Automation Systems."

C. Face and Bypass Dampers: Opposed blade, galvanized steel dampers with steel operating rods rotating in sintered bronze or nylon bearings mounted in a single galvanized steel frame and with operating rods connected with a common linkage. Provide blade gaskets and edge seals, and mechanically fasten blades to operating rod.

D. Outdoor and Return Air Mixing Dampers: Parallel blade, galvanized steel dampers mechanically fastened to steel operating rod in reinforced cabinet. Connect operating rods with common linkage and interconnect linkages so dampers operate simultaneously.

E. Mixing Section: Multiple blade, air mixer assembly located immediately downstream of mixing section.

F. Combination Filter and Mixing Section:

1. Cabinet support members shall hold two (2) inch thick, pleated, flat, permanent or throwaway filters.

2. Multiple blade, air mixer assembly shall mix air to prevent stratification, located immediately downstream of mixing box.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine areas and conditions, with installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the work.

B. Examine casing insulation materials and filter media before air handling unit installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.

C. Examine roughing in for hydronic, piping systems and electrical services to verify actual locations of connections before installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

E. Install in accordance with manufacturer's Installation & Maintenance instructions.

### 3.2 INSTALLATION

A. Equipment Mounting:

1. Install air handling units on cast in place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Architectural Specification Section's "Cast in Place Concrete." and/or "Miscellaneous Cast in Place Concrete."
2. Comply with requirements for vibration isolation and seismic control devices specified in Division 23 Specification Section "Vibration and Seismic Controls for HVAC Systems."

B. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with new, clean filters.

C. Install filter gauge, static pressure taps upstream and downstream of filters. Mount filter gauges on outside of filter housing or filter plenum in accessible position. Provide filter gauges on filter banks, installed with separate static pressure taps upstream and downstream of filters.

D. Provide one extra set of fan belts, filters for each unit.

### 3.3 CONNECTIONS

A. Comply with requirements for piping specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to air handling unit to allow service and maintenance.

C. Connect piping to air handling units mounted on vibration isolators with flexible connectors.

D. Connect condensate drain pans using NPS 1-1/4, ASTM B 88, Type M copper tubing. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.

E. Water Piping: Comply with applicable requirements in Division 23 Specification Section “HVAC Piping Systems and Specialties.”

F. Connect duct to air handling units with flexible connections. Comply with requirements in Division 23 Specification Section "HVAC Duct Systems and Accessories."

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Leak Test: After installation, fill water coils with water, and test coils and connections for leaks.
2. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Air-handling unit or components will be considered defective if unit or components do not pass tests and inspections.

E. Prepare test and inspection reports.

3.5 STARTUP SERVICE

A. Engage a factory authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

2. Verify that shipping, blocking, and bracing are removed.
3. Verify that unit is secure on mountings and supporting devices and that connection's to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, controllers, and switches.
4. Verify proper motor rotation direction, free fan wheel rotation, and smooth bearing operations.
5. Verify that bearings, and other moving parts are lubricated with factory-recommended lubricants.
6. Verify that outdoor and return air mixing dampers open and close, and maintain minimum outdoor air setting.
7. Comb coil fins for parallel orientation.
8. Install new, clean filters.
9. Verify that manual and automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.

B. Starting procedures for air handling units include the following:

1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm.
2. Measure and record motor electrical values for voltage and amperage.
3. Manually operate dampers from fully closed to fully open position and record fan performance.

3.6 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Comply with requirements in Division 23 Specification Section "Testing, Adjusting, and Balancing HVAC Systems" for air handling system testing, adjusting, and balancing.

3.7 CLEANING

A. After completing system installation and testing, adjusting, and balancing air handling unit and air distribution systems and after completing startup service, clean air handling units internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train the owner's maintenance personnel to adjust, operate, and maintain air handling units.

END OF SECTION 237313

# SECTION 238119 – SELF CONTAINED AIR CONDITIONING UNITS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 23.

### 1.2 SUMMARY

A. This section includes the requirements for self contained air cooled air conditioning units intended for indoor installations and related equipment as follows:

1. Vertical floor mounted ducted unit

### 1.3 ACTION SUBMITTALS

A. Product Data: For each specified product, include manufacturers cut sheets, dimensional data, performance data, refrigerant type, micro-processor controller, installation instructions, wirings diagrams, power requirements, specified options, and warranty information.

### 1.4 INFORMATIONAL SUBMITTALS

A. Warranty: Sample of special warranty.

B. Field quality-control reports.

### 1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Include a copy of each approved submittal along with any applicable maintenance data in the project operation and maintenance manual.

B. Maintenance Material Submittals:

1. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

a. Filters: One (1) set of filters for each unit.
b. Fan Belts: One (1) set of belts for each unit.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ARI Compliance:

1. Applicable requirements in ARI 210/240.
2. Applicable requirements in ARI 340/360.
3. Applicable requirements in ARI 390.

C. ASHRAE Compliance:

1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Ventilation Rate Procedures," and Section 7 - "Construction and Startup."

D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

1.7 COORDINATION

A. Coordinate layout and installation of air cooled units and wall louvers with other construction including light fixtures, HVAC equipment, fire suppression system, and partition assemblies.

B. Coordinate sizes and locations of equipment supports, and wall penetrations with actual equipment provided.

1.8 WARRANTY/GUARANTEE

A. See Division 23 Specification Section “Basic Mechanical Requirements – HVAC” for warranty and guarantee requirements.

**PART 2 - PRODUCTS**

2.1 GENERAL PRODUCT REQUIREMENTS

A. Equipment Design and Selection: Self contained water cooled DX units shall be designed and selected in accordance with the scheduled capacities on the drawings and the requirements of this specification.

B. Basis of Design: The basis of design is self contained air conditioning equipment manufactured by United Cool Air as follows:

1. Floor Mounted Vertical Ducted Units: Model Verticool Aurora.

C. Other Acceptable Manufacturers: Subject to compliance with requirements, provide self contained air conditioning equipment by one (1) of the following:

1. Above Air Technologies
2. Compu-Aire Inc.

D. BAS Interface: Units shall be furnished with software communications interface capability for connectivity to the external Building Automation System through Bac Net IP Protocol and comply with the points list in this specification.

2.2 FLOOR MOUNTED PACKAGED AC UNIT

A. General Description:
1. Furnish and install an indoor vertical air conditioner system designed to control space temperature and humidity levels. It shall have the performance, electrical characteristics, and air path configurations as defined in the product schedule for the space to be conditioned.
2. The unit(s) shall be a VertiCool Aurora modular air-cooled model manufactured by United CoolAir, York, Pennsylvania.
3. The unit(s) shall be installed as a floor mounted Single Package system.
4. All systems shall be shipped with a full factory refrigerant charge and be ready to wire once the unit has been placed on site.
5. A wiring diagram shall be affixed to each unit. A printed Installation, Operation and Maintenance Manual shall be provided with each unit. All units shall be suitably labeled for safety purposes and for access.

B. Quality Assurance:
1. Unit and refrigeration system(s) shall comply with ASHRAE 15, Safety Standard for Mechanical Refrigeration.
2. Unit shall be certified in accordance with UL Standard 1995/CSA C22.2 No. 236-11, safety Standard for Heating and Cooling Equipment.
3. Unit shall be factory evacuated, charged with refrigerant R-410A, leak tested, and functionally tested prior to shipment. When units are shipped as separate evaporator and condensing sections, each will be factory evacuated, charged with refrigerant R-410A, leak tested and functionally tested as a complete system prior to shipment.

C. Submittals:
1. Literature shall be provided that indicates unit dimensions, applicable clearances, unit operating weights, capacities, blower performance, filter information, factory supplied options, electrical characteristics, and connection requirements.
2. Installation, Operation, and Maintenance manual along with start-up procedure shall be provided.

D. Delivery, Storage, and Handling
   1. Sections shall be shipped with all access panels in place and suitably affixed to prevent damage during transportation and thereafter while in storage either offsite or on the jobsite.
   2. Unit and/or unit sections shall be stored in a clean, dry place protected from construction traffic and the natural elements.
   3. Installing contractor shall follow industry accepted practices and instructions in the Installation, Operation and Maintenance manual for moving unit and/or sections and for the assembly of sections where required.
   4. Unit or section of the unit shall not be disassembled in the field, except as designed for, in order to facilitate placement into the building or mechanical space. Any disassembly of the unit or unit sections not incorporated into the basic design would act to void the unit warranty and reduce the factory quality assurance process.

E. Warranty:
   1. Manufacturer shall provide a "parts only" limited warranty for a period of 12 months from the date of equipment start-up or 18 months from date of shipment from the factory, whichever is less.
   2. Manufacturer shall provide a "compressor parts only" limited warranty for a period of 60 months from the date of equipment start-up or 66 months from date of shipment from the factory, whichever is less.
   3. Manufacturer's limited warranty shall be for parts only. Labor is not included.

F. Cabinet:
   1. Cabinet shall be unpainted non-weatherized and constructed of scratch resistant heavy duty galvanized G90 steel.
   2. Cabinet shall be modular in construction, shipped as a self-contained unit on a single skid from the manufacturer. Units shall be able to ship in two sections, on separate skids, depending on unit size or if ordered as sectional shipment in order to facilitate rigging and placement.
   3. Cabinet access panels shall fit into recessed pockets within the cabinet structure and held in place with screws. Recessed areas will be lined with flexible gasket to minimize air leakage.
   4. Panels shall allow access to key internal components to facilitate installation, maintenance and servicing of the unit.
   5. Access to high and low side Schrader fittings for refrigerant pressures, while unit is operational, shall be made through holes provided in the condensing section corner posts.
   6. All duct flanges shall be factory-installed on each cabinet section prior to shipment.
   7. Cabinet and removable panels shall be lined with bio-based ½", 2lb/ft3 density fiberglass thermal/acoustic insulation which meets NFPA 90A and 90B/ASTM-C1071 Type 1/ASTM G 21/ CAN ULC S102-M88 / CAN CGSB-51.11-92 requirements. Insulation shall be certified as a low emitting product by The

Greenguard Environmental Institute. Insulation shall be composed of more than 60% recycled post-consumer glass content. Insulation shall not promote or support the growth of mold, fungi or bacteria.

G. Refrigerant Circuit:
1. Each refrigerant circuit shall be provided with high and low-side Schrader access valves, sight glass with integral moisture indicator visible from cabinet exterior, filter-drier, maximum operating pressure (MOP) expansion valve with external equalizer line, manual reset high and auto-reset low pressure safety switches.
2. Each refrigerant circuit will be factory leak tested, evacuated, and charged with R-410A refrigerant prior to shipment. No field piping, brazing, evacuation or refrigerant charging shall be required for single package installations.
3. Each section (12 through 35 tons) is to be provided with resealable refrigerant fittings in order to preserve the factory refrigerant charge and to facilitate assembly of split sections without loss of the refrigerant circuit integrity.

H. Compressor:
1. Each compressor shall be high-efficiency, heavy duty, single-speed, suction-cooled hermetic scroll type, operating at 3450 RPM on 60Hz. The compressor shall contain internal overload protection.
2. Compressor shall utilize internal spring vibration isolators and external rubber in shear (RIS) mounting to minimize sound and vibration transmission.
3. Units with multiple compressors shall have separate independent refrigerant circuits.
4. Lead compressor shall be a digital scroll type.
5. Compressor Crankcase Heater - Each compressor shall be provided with a wraparound electrical cable resistance heater used to prevent migration and condensation of liquid refrigerant to the compressor crankcase while system is off.

I. Evaporator Coil Section:
1. The direct expansion evaporator coil shall be configured for draw-thru airflow design for uniform air distribution across the coil face. It shall be made with heavy wall seamless copper tubes mechanically expanded into tempered aluminum fins with drawn self-spacing collars. Coil end sheets shall be hot-dipped galvanized. All coils shall be factory leak checked under pressure. Dual circuit units shall utilize interlaced evaporator coils.
2. Evaporator coil section shall be equipped with a double sloped 304 stainless steel drain pan with minimum 1" IPS condensate drain connections. Condensate shall be removable from either side of the unit. Drain pan shall extend to the entire length and width of the evaporator coil.

J. Air-Cooled Condensing Section:
1. The condenser coil shall be configured for draw-thru airflow design for uniform air distribution across the coil face. It shall be made with heavy wall seamless copper tubes mechanically expanded into tempered aluminum fins with drawn

self-spacing collars. Coil end sheets shall be hot-dipped galvanized. All coils shall be factory leak checked under pressure.

2. Condensing Filters - Condensing section shall be provided with a filter frame with air filters which shall be nominal 2" depth pleated, throwaway type panel filters consisting of cotton and synthetic or synthetic only media with galvanized expanded metal backing and moisture resistant enclosing frame. The filter shall be classified for flammability by Underwriters Laboratories, Inc. as Class 2.
3. The filter media shall have an efficiency of MERV 8 based on ASHRAE test standard 52.2.

K. Blower / Motor Assemblies:
1. The evaporator and condenser centrifugal blower assemblies shall be belt driven with double width, double inlet housing and forward-curved tab locked blades mounted on a solid keyed shaft. The hub shall be precision machined and incorporate a keyway and a locking screw.
2. The shaft shall be hardened steel, precision ground and polished. Shafts shall include a keyway for the wheel hub and the pulley. All shafts shall be coated for corrosion protection.
3. Bearings shall be sized for an L50 life of 200,000 hours of service per AFBMA standards. Bearings shall be mounted in a rubber inter-liner fitted into a spider bracket for 3 through 15 ton evaporator blowers. These bearings shall be permanently lubricated and sealed. All 12 through 35 ton condenser blowers and 20 through 35 ton evaporator blowers shall have pillow block bearings. All pillow block bearings shall include re-lubrication fittings.
4. All wheels are to be balanced, both statically and dynamically, to an accuracy grade of G = 6.3 in accordance to DIN ISO 1940-1 and ANSI S2.19-1989.
5. The motor shall have an adjustable base for tensioning of belts and a locking mechanism to prevent the motors from shifting.
6. The blower fixed pulley shall be cast iron, keyed to the shaft, and the motor sheave shall have an adjustable pitch in order to allow for field adjustment of blower speed in order to match the system airflow requirements.
7. Blower motors shall be open drip proof, T Frame having class B insulation, NEMA B design and having a 1.15 service factor. Motors 1 HP and larger shall be Premium Efficiency. Motor shall have internal overload protection and permanently lubricated ball bearings. Motors shall be rigidly mounted to an adjustable motor frame.

L. Electrical System:
1. The electrical system shall conform to National Electric Code (NEC) requirements.
2. Unit shall have a single electrical control panel. A single point power connection shall be provided through the side of the condensing section cabinet for self-contained units. Separate power supplies shall be provided through the sides for each section when the system is installed as a split system. Power shall be connected to factory installed terminal blocks.

3. All electrical components (blower motors, compressor(s), electric heat stages, etc.) shall have individual definite purpose contactors.
4. A low-voltage transformer, with protection, shall be provided to supply 24 VAC to the control circuit.
5. A terminal strip shall be factory installed internal to the control box and be clearly labeled for thermostat and interlock wiring connections.
6. Each component shall be safety agency listed as required. All electrical components shall be labeled to co-ordinate with the unit wiring diagram provided.

M. Evaporator Air Filtration:
1. Evaporator air filters shall be nominal 2" depth pleated, throwaway type panel filters consisting of cotton and synthetic or synthetic only media with galvanized expanded metal backing and moisture resistant enclosing frame. The filter shall be classified for flammability by Underwriters Laboratories, Inc. as Class 2.
2. The filter media shall have an efficiency of MERV 8 based on ASHRAE test standard 52.2.
3. The filter face area shall contain not less than 10 pleats per lineal foot. Media support shall be heavy gauge expanded, electro-galvanized metal with grid members being no less than 0.025"wide, providing an open area of not less than 96%. The grid shall be 100% bonded to the media on the air exiting side to eliminate media vibration and pull-away. The grid shall be formed to provide a uniform V-shaped pleat with the open area on the air exiting matched to the open area on the air entering side for maximum utilization of the media and low airflow resistance. The enclosing frame shall be constructed of a rigid, high wet strength board.

N. System Options:
1. SCR Electric Heat - The electric heating coil shall be controlled through a silicon controlled rectifier (SCR) with an extruded aluminum heat sink and solid state logic control system.
2. Modulating Hot Gas Reheat - Unit shall include modulating hot gas reheat consisting of a factory-mounted aluminum fin, copper tube, reheat coil, liquid receiver, modulating hot gas valve, and check valve.
3. Condenser Fan VFD - Unit shall be suitable for operation with outside ambient temperature down to 0 Deg. F. using variable frequency drive (VFD) control of condenser fan speed. Unit shall include factory-mounted VFD, protective enclosure, and refrigerant pressure transducer. A circuit breaker shall be provided for the motor in lieu of the standard motor contactor.
4. Internal Hot Gas Bypass - Each refrigerant circuit in the condensing section shall be provided with factory-installed internal hot gas bypass capability that diverts a portion of discharge gas directly into the suction line of the compressor. Circuit shall include a hot gas bypass valve (on/off), suction line accumulator and quench valve. Each refrigerant circuit shall include a manual shutoff valve on hot gas bypass line to be used for isolation of the hot gas bypass capability during unit start-up, testing, or maintenance.

5. All internal hot gas bypass components shall be factory-installed and shall not require additional field-installed refrigerant line(s). The lead refrigerant circuit shall be provided with a factory-installed modulating hot gas bypass valve that diverts a portion of the discharge gas into the suction line of the compressor. All lag circuits will be on/off operation.
6. Quench Valve / Suction Accumulator – Each refrigerant circuit shall be provided with a factory installed quench valve and suction accumulator combination.
7. Suction Line Accumulator - Each refrigerant circuit shall be provided with a factory installed suction accumulator.
8. Oil Separator - Each refrigerant circuit shall be provided with a factory installed oil separator.
9. Liquid Line Receiver - Each refrigerant circuit shall be provided with a factory installed liquid line receiver.
10. Liquid Line Solenoid - Each refrigerant circuit shall be provided with a factory installed liquid line solenoid.
11. Evaporator Fan VFD – Unit shall be suitable for variable air volume (VAV) operation using a variable frequency drive (VFD) control of the evaporator fan speed. VFD shall be shipped loose for field mounting and programming. A duct mounted supply air pressure transducer shall be provided as a shipped loose item for field mounting. A circuit breaker shall be provided for the motor in lieu of the standard motor contactor.
12. Discharge Plenum w/ Duct Flanges – A discharge plenum with duct flanges shall be factory supplied.
13. Air Side Economizer (w/ Marvel "Plus") – An air side economizer package shall be provided by the unit manufacturer. Air side economizer package shall include a mixing box with electrically operated dampers for return air and outside air, outdoor air enthalpy sensor, return air enthalpy sensor, mixed air temperature sensor and a supply air temperature sensor. Unit mounted terminal blocks shall be provided for field wiring of sensors.
14. Each sensor is to be preconfigured and labeled by the unit manufacturer for its specific function.
15. An electrical diagram shall be provided with the unit.
16. The air side economizer shall be activated when the outside air conditions of enthalpy and temperature can satisfy the cooling requirements. The outside air dampers and return air dampers shall be modulated to control the cooling load requirement. Mechanical cooling can be enabled as an assist to the air side economizer if it is full open and the cooling load is not being satisfied.
17. Dirty Filter Switch - Unit shall include a factory-installed, pressure differential type dirty filter switch that is set to read across the evaporator filter bank.
18. Airflow Proving Switch - Unit shall include a factory-installed, pressure differential type loss of airflow proving switch that is set to read pressure drop across the evaporator blower section. Upon loss of air flow, this control shall terminate system operation.
19. Freezestat - Unit shall include a factory-installed fully encapsulated, automatic reset type freezestat clamped to each compressor suction line and, upon opening,

shall shut down the compressor and allow the blower to continue operating until the freezestat resets.

20. Firestat - A factory supplied firestat shall be shipped loose for field installation. Device shall be a manual reset, adjustable setting, type which is to be field installed in the [supply] [return] air duct and wired to the unit electrical control panel. Upon activation, this control will terminate system operation.
21. Smoke Detector - A factory supplied smoke detector shall be shipped loose for field installation in the [supply] [return] air duct and wired to the unit electrical control panel. Upon activation, this control will terminate system operation.
22. Dehumidistat - A factory supplied dehumidistat shall be shipped loose for field installation on a wall in the conditioned space and wired to the unit electrical control panel.
23. Compressor Anti-short Cycle Timer - Unit shall include a factory-mounted and wired adjustable compressor anti-short cycle timer that will provide a minimum compressor off time.
24. Condensate Pump - A condensate pump for the automatic collection and removal of condensate from the unit shall be factory provided. Pump shall be shipped loose for field mounting. Pump shall consist of a 1/30 H.P. high performance motor, a ½ gallon ABS housing and cover, ABS collection tank, vertical centrifugal pump with glass-filled polypropylene impeller and stainless steel shaft, check valve, power cord and automatic controls.
25. A separate 115-1-60 power supply for the condensate pump is to be field-provided.
26. Phase reversal sensor - Unit shall include a factory-mounted and wired phase reversal sensor.
27. Dry Electrical Contacts - Unit shall include 2 set(s) of dry NO / NC electrical contacts for field connection to auxiliary devices furnished by others.
28. Thermostat Programmable - A programmable thermostat shall be factory provided. Thermostat shall have a Hybrid Dot Matrix display, menu-driven setup, battery backup, user lockout, 12/24 hour clock, 7 day programming with 4 periods per day, change filter indicator, energy use monitor, non-volatile memory for all programs and settings, and programmable settings for High/Low limit, dead bands, fan delay, temperature differentials, minimum/maximum run/off times, and fan on/off delay time.
29. Marvel Plus Microprocessor Control - The unit shall contain the Marvel Plus self-contained programmable microprocessor controller. The factory mounted controller shall include the following:
    a. An 8 line by 22 character white backlit LCD wall mounted screen display shipped loose for field mounting.
    b. English Text
    c. System Status Display
    d. Active Temperature Display
    e. 6 Button Navigation / Submenu
    f. Manual control from the controller keypad.
    g. Password protection (Optional)

h. Automatic restart from a loss of power
i. Real Time Clock (back up of clock during power outage)
j. 7 Day Occupied / Unoccupied Period Programmability
k. Night Set Back / Up Capability
l. Auto Daylight Savings Time
m. BACnet™, LonWorks® & Modbus compatibility
n. Return Air Temperature Sensor
o. Supply Air Temperature Sensor
p. Duct Static Pressure Transducer
q. Air Pressure Switch (High Static) input
r. High & Low Refrigerant Pressure Safety Switch Inputs
s. Anti-short Cycle Protection
t. 4 MB Flash memory
u. 10 Analog inputs
v. 18 Digital inputs
w. 6 Analog outputs
x. 18 Digital outputs
y. Plastic housing shall be DIN Rail mounted
z. Plug-In Screw Down Type connectors
aa. Alarm history (Up to 50 alarms)
bb. System Enables Menu
cc. Time Clock Menu
dd. Alarm Set Point Menu
ee. Equipment Run Hours Menu
ff. Set Point Menu
gg. Technician Menu
hh. Factory Menu
ii. Unit shall include 100' of cable for connection of wall display to unit mounted microprocessor.
jj. Airflow proving switch
kk. Dirty filter switch
ll. Drain pan overflow switch
mm. pLAN Network capability
nn. Microprocessor shall include BMS Interface BACnet
oo. The unit shall provide the following visual and audible alarms:
    1) High duct static pressure
    2) High Refrigerant Pressure (each compressor)
    3) Low Refrigerant Pressure (each compressor)
    4) Loss of Air Flow
    5) Evaporator Motor Overload
    6) High Supply Air Temperature
    7) Low Supply Air Temperature
    8) High Return Air Temperature
    9) Low Return Air Temperature
    10) Dirty Filter

11) Drain Pan Overflow
12) Sensor Failure
13) Smoke Detector
14) Firestat
15) Heater High Limit

pp. Unit shall include the following sensors for field installation and connection to the microprocessor:
1) ___Wall-Mounted temperature/humidity sensor
2) ___Duct-Mounted temperature/humidity sensor

O. Factory Run Test:
1. Functional Run Test
a. Each complete system shall be functionally run-tested prior to shipment. A dielectric withstand test shall also be conducted. All data is to be recorded on a factory test form and shall include all electrical components, motors, compressors, safeties, controls, along with refrigerant pressure and electrically operated options.
b. Each refrigerant circuit shall have a complete refrigerant circuit leak test and all data is to be included in the factory test form(s).
c. Upon request, a copy of the factory Unit Test Sheet shall be provided.
d. A final inspection prior to shipment is also to be conducted and documented.

P. Execution
1. Installation, Operation and Maintenance
a. Installation, Operation and Maintenance manual shall be provided with the unit.
b. Installing contractor shall install unit in accordance with industry accepted practices and Installation, Operation and Maintenance Manual.
c. Industry accepted Start-Up procedures and requirements shall be complied with to ensure safe and reliable operation of the unit.

## PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with the installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the work.

B. Examine roughing-in for hydronic piping systems to verify actual locations of piping connections before equipment installation.

C. Examine project area for suitable conditions where air cooled air conditioning units will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Anchor units to structure.

B. Install air cooled units air conditioners level and plumb, maintaining manufacturer's recommended clearances. Install according to ARI Guideline B.

C. Vertical Water Cooled Units Computer Rooms: Comply with requirements for vibration isolation devices specified in Division 23 Specification Section "Vibration and Seismic Controls for HVAC Systems."

1. Minimum Deflection: One quarter (1/4) inch.

3.3 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties. Arrange piping to remain clear of manufacturers recommended space for maintenance and service.

B. Condensate Drainage Connection: Comply with applicable requirements in Division 22 Specification Section "Storm Water Piping System and Specialties." Provide connections for condensate drain.

C. Duct Connections: For ducted units provide flexible connections for supply and return duct connections to the units.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation, and inspect for refrigerant leaks.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Provide a seven (7) days notice to UMB for owner to witness the inspection and testing.

D. Units will be considered defective if they do not pass tests and inspections.

E. Prepare and submit test and inspection reports to the CM.

3.5 STARTUP SERVICE

A. Engage a factory authorized service representative to perform startup service.

B. Provide a seven (7) days notice to UMB for owner to witness the start up service.

3.6 COMMISSIONING

A. See Division 23 Specification Section “Commissioning Mechanical Systems” for requirements.

3.7 DEMONSTRATION

A. Engage a factory authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.

B. Provide a seven (7) days notice to UMB for owner to attend the demonstration.

END OF SECTION 238119

# SECTION 238219 – HEATING AND COOLING TERMINAL UNITS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 23.

### 1.2 SUMMARY

This section includes the requirements for heating terminal units as follows:

1. Unit heaters.
2. Wall heater.

### 1.3 ACTION SUBMITTALS

A. Product Data: For each specified product, include manufacturers cut sheets, dimensional data, performance data, installation instructions, wirings diagrams, power requirements, specified options, and warranty information.

B. Shop Drawings:

1. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Include diagrams for power, signal, and control wiring.

C. Samples for Initial Selection: For units with factory-applied color finishes.

### 1.4 INFORMATIONAL SUBMITTALS

A. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

B. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

C. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Field quality control reports.

### 1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Include a copy of each approved submittal along with any applicable maintenance data in the project operation and maintenance manual.

1. In addition to items specified in Section "Operation and Maintenance Data," include the following:

a. Maintenance schedules and repair part lists for motors, coils, integral controls, and filters.

1.6 PERFORMANCE REQUIREMENTS

A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

B. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.7 QUALITY ASSURANCE

A. Comply with NFPA 70.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Factory-packaged and tested units rated according to AHRI 440, ASHRAE 33, and UL 1995

1.8 COORDINATION

A. Coordinate layout and installation of heating terminal units and suspension system components with other construction that penetrates or is supported by ceilings, including light fixtures, HVAC equipment, fire suppression system components, and partition assemblies.

1.9 WARRANTY/GAURANTEE

A. See Division 23 Specification Section “Basic Mechanical Requirements – HVAC” for warranty and guarantee requirements.

## PART 2 - PRODUCTS

### 2.1 GENERAL PRODUCT REQUIREMENTS

A. Equipment Design and Selection: Heating terminal units shall be designed and selected in accordance with the scheduled capacities on the drawings and the requirements of this specification.

B. Basis of Design: The basis of design for heating terminal units are units manufactured by Trane and/or Vulcan as follows:

1. Unit Heater (UH) - Trane Model 'UHEC'
2. Wall Heater (WH) – Trane Model UHAA.

C. Other Acceptable Manufacturers: Subject to compliance with requirements, provide heating terminal units by one (1) of the following:

1. UH – Airtherm, Rittling or Modine
2. WH – Airtherm, Rittling or Modine

### 2.2 UNIT HEATERS

A. Description:
1. Heaters shall be installed and wired in accordance with the manufacturer's recommendations and applicable national and local codes.

B. Casing:
1. Casings fabricated of die-formed, heavy gauge steel and finished in high gloss, baked enamel. Supply air shall be drawn through a stamped louver periphery evenly across the heating element, and discharged through an outward drawn venturi. Adjustable discharge louvers shall be provided to control the direction of airflow. A large, hinged access door shall extend the width of the heater and locked in position by quarter-turn fasteners. Heater and supply wiring diagram shall be permanently attached to the inside of the access door.

C. Elements:
1. Elements shall be high mass, all steel tubular finned type, copper brazed. Centrally located and installed in fixed element banks.

D. Motors:
1. Motors shall be totally enclosed, all angle industrial rated. All units 3.3 through 20 kW will utilize sealed bearings to assure permanent lubrication. 25 through 50 kW units are provided with a two-speed, permanent capacitor-type.

E. Fan Blades:

1. Fan blades shall be of the axial flow type designed for quiet efficient operation. Fan speed does not exceed 1,600 rpm (26.7 R.P.S.).

F. Wiring:
1. Heaters designed for a single circuit, with elements, motor and control circuits subdivided with factory wired fuses to conform to the National Electric Code and Underwriter's Laboratory, Inc., Standard 1278. All three-phase heaters shall have balanced phases.

G. Thermal Overload Protection:
1. All heaters shall be equipped with automatic reset thermal overloads which shut down the element and motor if safe operating temperatures are exceeded.

H. Fusing:
1. Element, motor and transformer primary fusing are factory installed and wired where required by NEC. Branch circuit fusing is installed where required (48 amps and up).

I. Control:
1. Contactors and control circuit transformers where required are factory installed and wired. Only direct line supply and thermostat connections in the field are required. Two-stage operation is standard on all units 25 kW and larger with use of two-stage thermostats. Builtin fan override is provided to purge unit casing of excess heat after unit shutdown. The units are listed under the Reexamination Service of Underwriter's Laboratories, Inc. Units are warranted to be free from defective material and workmanship for a period of one year with the exception of the heating elements which are warranted for five years.

J. Control Options:
1. Integral power disconnects (where applicable) — supplied to disconnect all ungrounded connectors in the "Off" position. Disconnect is isolated from unit wiring by use of a metal plate and fisch paper.
2. Thermostats (unit-mounted); (wall- mounted) — heavy-duty hydraulic actuating-type. Thermostat range 45°F (7.2°C) to 90°F (32.2°C). Unit-mounted thermostat can be rendered tamperproof by removing the temperature adjustment knob.
3. Independent fan operation for summer air circulation — provided from a line or low voltage (unit- mounted) (wall- mounted) fan switch.
4. Combination low voltage wall thermostat and fan switch — provided to give wall mounted control of element and fan.
5. Stratification thermostat with a range of 70°F (21.1°C) to 130°F (54.4°C) — provided for units mounted in the vertical discharge position to provide an energy saver cycle recovering warm stratified air.

K. Optional Diffusers:

1. Louver Cone Diffuser — shall have individually adjustable blades to permit increased floor coverage at 45 degrees open. Additional throw is accomplished when blades are 90 degrees vertical, allowing higher mounting height.

2.3 WALL HEATER

A. Furnish and install heavy-duty forced air wall heaters, Series 3320. Heaters shall be constructed of a 18-gauge steel housing with a 14-gauge extruded aluminum frame. The steel grille and heater box shall be painted with a rust resistant dark brown baked enamel color finish. Rough-in dimensions of 19 3/16" high x 14 3/16" wide x 4" deep. Power wiring shall be connected through two 1/2" knockouts in the top of the heater and one 1/2" knockout on the bottom of the heater. Units shall be available in ratings from 1500 to 4800 watts at 240, 208 and 277 volts and 1500 watts at 120 volts. The heaters shall have a low-speed 600 rpm, four-pole motor which drives a vane axial blower to deliver a quiet 175 cfm of down flow air.

B. The heating element shall be sealed tubular type with large, parallel steel fins for quick heat transfer.

C. Unit's shall have as standard, thermal overload cut-off for added safety, fan delay switch, manual tamper resistant disconnect switch and a tamper resistant thermostat which are calibrated to provide a range of 55 F to 85 F. All items factory installed and wired.

D. Provide optional accessories surface mounting adapter and day-night relays. All heaters are listed by Underwriter's Laboratories, Inc. The heating element are supplied with a manufacturer's five - year limited warranty.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. With the installing contractor present examine the locations for each heating and cooling terminal unit for compliance with the requirements for installation tolerances and other conditions affecting performance of the work.

B. Examine roughing in locations and verify the required mechanical and electrical connections have been completed and the surface areas are level and clean.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Unit Heater Installation:

1. Install unit heaters to comply with NFPA 90A.
2. Install unit heaters level and plumb.

3. Suspend unit heaters from structure with elastomeric hangers and seismic restraints. Vibration isolators and seismic restraints are specified in Division 23 Specification Section "Vibration and Seismic Controls for HVAC Systems."
4. Install wall mounted thermostats and switch controls in electrical outlet boxes at heights to match lighting controls. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:

B. Ground equipment according to Division 26 Specification Section "Grounding and Bonding for Electrical Systems."

C. Connect wiring according to Division 26 Specification Section "Low Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform the following tests and inspections with the assistance of a factory authorized service representative:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

D. Prepare test and inspection reports.

3.5 ADJUSTING

A. Adjust initial temperature set points.

B. Occupancy Adjustments: When requested within twelve (12) months from the date of Substantial Completion, provide onsite assistance in adjusting system to suit actual occupied conditions. Provide up to two (2) visits to Project during other than normal occupancy hours for this purpose.

3.6 DEMONSTRATION

A. Engage a factory authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fan coil units.

END OF SECTION 238219

# SECTION 260000 - BASIC ELECTRICAL REQUIREMENTS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this section and all other Electrical Specification Sections.

### 1.2 SUMMARY

A. This Section includes general administrative and procedural requirements, as well as the following basic electrical materials and methods:

1. Submittals.
2. Record documents.
3. Operation and Maintenance manuals.
4. Rough-ins.
5. Electrical installations.
6. Cutting and patching.
7. Access to electrical installations.

B. Summary of Work:

1. Provide a complete integrated electrical system in accordance with the intent of these specifications and the accompanying drawings.

### 1.3 REFERENCED ORGANIZATIONS AND CODES

A. The following list of abbreviations, are utilized within the specifications and are provided as a reference.

B. All work in Divisions 26, 27, and 28 shall comply with the latest version of following codes and regulations as adopted by the State of Maryland and the State Fire Marshal, unless otherwise specified.

1. NFPA (National Fire Protection Association).
2. NESC (National Electrical Safety Code).
3. ADA (American with Disabilities Act).
4. ANSI (American National Standards Inst.).
5. OSHA (Occupational Safety & Health Act).
6. COMAR (Code of Maryland Regulations).
7. UL (Underwriters Laboratories).
8. IBC (International Building Code).
9. State of Maryland Fire Prevention Code.
10. ANSI/EIA/TIA.

11. NETA (National Electrical Testing Association).
12. NEMA (National Electrical Manufacturer's Association).
13. NECA (National Electrical Contractors Association).

## 1.4 OUTAGES

A. For all work requiring an outage, the contractor shall submit an outage request to the UMB Project Manager, using the UMB Standard Request for Outage Form which is available through the UMB Design and Construction Web Site at http://www.umaryland.edu/designandconstruction/, under the Documents Link. The existing mechanical/electrical systems shall remain operational unless turned off by University personnel during the construction of the project. For each electrical outage request include a photograph of the panel index schedule for each panel affected by the outage.

B. Unless otherwise specified, outages of any services required for the performance of this contract and affecting areas other than the immediate work area shall be scheduled at least ten days (10) days in advance with the Office of Facilities Management. All such outages shall be performed on other than normal duty hours.

C. All electrical outages which will interfere with the normal use of the building in any manner shall be done at such times as shall be mutually agreed upon by the contractor and the Office of Facilities Management.

D. The contractor shall include in his price the cost of all premium time required for outages and other work which interferes with the normal use of the building, which will be performed, in most cases, during other than normal work time and at the convenience of the University.

E. The operation of electrical equipment; required to achieve an outage must be accomplished by University personnel only. Prospective subcontractors under this section are cautioned that the unauthorized operation of electrical equipment or other control devices by their personnel can result in extremely serious consequences for which the contractor will be held accountable.

## 1.5 INSTALLER'S QUALIFICATIONS

A. Electrical Installer shall submit the following evidence:

1. Five (5) comparable completed projects.
2. Reference letters from minimum of three (3) registered professional engineers, general contractors, building owners, explaining proficiency, quality of work, or other attribute on projects of similar size or substance.
3. Copy of Maryland Master Electrician's License.
4. Local or State license where required.
5. BICSI and NICET certification, where required by these specifications.

B. The electrical installer shall utilize a full time project foreman in charge of all electrical work.

1. Fully qualified and experienced in such work.
2. Available, on site, at all times during construction.
3. All communication shall be through this person.

C. Installer of specialized systems such as Fire Alarms, telecommunication systems, etc. shall meet the requirements of the associated spec section(s).

1.6 CUTTING, WELDING, BURNING

A. Before the contractor and/or any sub-contractor commence's any cutting, welding, and/or burning, the contractor shall obtain a hot work permit from Environmental Health and Safety at extension 1-410-706-3490.

B. The hot work permit copy shall remain on the job site at the hot work location until such work is completed at which time the permit shall be returned to Environmental Health and Safety.

1.7 WORK PERFORMANCE

A. All electrical work must comply with the requirements of NFPA 70 (NEC), NFPA 70B, NFPA 70E, OSHA Part 1910 subpart J, OSHA Part 1910 subpart S and OSHA Part 1910 subpart K in addition to other references required by the contract.

B. Before initiating any work, a job specific work plan must be developed by the contractor. The work plan must include procedures to be used on and near the live electrical equipment, barriers to be installed, and safety equipment to be used and exit pathways.

C. Job site and worker safety are the responsibility of the contractor. Compliance with the requirements of NFPA 70E is subject to ongoing inspection by University personnel and failure to comply will result in an immediate Stop Work order being issued and enforced at the contractor's expense.

D. Energized electrical conductors and circuit parts to which an employee might be exposed shall be put into an electrically safe work condition before an employee performs work any time the employee is within the limited approach boundary or, where an increased risk of injury from an exposure to an arc flash hazard exists.

E. Outages should be scheduled a minimum of ten (10) days in advance.

F. Mandatory Requirements: The following requirements are mandatory:

1. Protective Equipment: Electricians must use full protective equipment (i.e., certified and tested insulating material to cover exposed energized electrical

components, certified and tested insulated tools, etc.) while working on energized systems in accordance with NFPA 70E.

2. UMB Energized Work Permit: A UMB Energized Work Permit is required for any work on energized circuits or equipment. Permit must be approved by UMB Department of Operations and Maintenance prior to performing energized work. Submit the work permit with the outage request.

1.8 SUBMITTALS

A. General: Follow the procedures specified in Division 01 Section "Submittals."

B. Product data as specified in the electrical specifications.

C. Shop drawings detailing fabrication and installation requirements for electrical equipment.

D. In addition to the following list, submit other shop drawings as may be requested by UMB.

1. Divisions 26, 27, & 28:
   a. Compression Wire Connectors
   b. Fire Resistant Sealant
   c. Ground Wire
   d. Surface Raceway
   e. Wireways
   f. Raceway, Boxes and Cabinets
   g. Wires and Cables
   h. Fire Alarm System: Refer to Division 28 Section “Digital, Addressable Fire Alarm System” for submittal requirements

E. In instances of complex field wired systems, including but not limited to: fire alarm system, the contractor shall submit:

1. Cut sheets of every component such as control panels, fire alarm devices, wire, etc.
2. The contractor shall submit detailed riser diagrams detailing point-by-point connections. Diagrams shall indicate cable on raceway between points.
3. Corresponding floor plans showing only this particular system with conduit and wire runs between points.
4. Both riser and floor plan shall indicate address of devices where applicable.
5. Calculations for battery capacity and voltage drop.
6. Preliminary programming information.

F. Submittal File Format: File formats for each submittal shall be electronically as follows:

1. Product Data: “pdf” file format.

2. Shop Drawings: “pdf” file format.
3. Coordinated Drawings: “pdf” or “dwg” file formats.

1.9 QUALITY ASSURANCE

A. Comply with NFPA 70 for components and installation.

B. Listing and Labeling: Provide products specified in this Section that are listed and labeled.

1. The Terms “Listed and Labeled”: As defined in the National Electrical Code, Article 100.
2. Listing and Labeling Agency Qualifications: A “Nationally Recognized Testing Laboratory” (NRTL) as defined in OSHA Regulation 1910.7.

C. Install all components and equipment per manufacturer’s written instructions.

D. Provide installation in accordance with recognized trade organizations and standards:

1. NEMA.
2. NECA “Standards of Installation”

1.10 COORDINATION DRAWINGS

A. General: When required participate in the preparation of the coordinated drawing effort for the project. See Specification Division 01 for general requirements.

B. Coordination Drawings: In addition to the requirements of the Specification Division 01 prepare the electric part for the coordination drawing effort. Work with the other trades to ensure the material and equipment installed as part on the electrical system will not be in conflict with the installation of material and equipment by the other trade contractors. Unless otherwise indicated the coordination drawings, including plans, sections, and elevations shall be prepared at a scale of not less than 1/4 inch = 1 foot- 0 inches. At a minimum, prepare coordination drawings for all mechanical rooms, electrical rooms and substation rooms.

C. File Format: Coordination drawings shall be in a layered structure form as CAD Files or PDF Files for each floor with searchable text as follows:

1. File Structure: The “pdf” or “dwg” files shall have separate layered structure for:

a. Building Elements: Indicate each building element on separate layers, such as:

1) Walls.
2) Reflected ceiling plan.
3) Room numbers.

b. Systems and Sub Systems: Indicate each system or sub system as warranted by congestion or complexity on separate layers such as:

1) Examples of Systems:
   a) Lighting System.
   b) Power Distribution System.
   c) Control/ SCADA System

2) Examples of Sub Systems:
   a) Normal Power.
   b) Emergency Power.

2. The layered electronic files shall allow building elements, building systems and sub systems to be viewed in isolation or in combinations that are user selectable when the drawing files are being displayed.

D. Coordination Effort: This coordination effort shall include detailing major elements, components, and systems of electrical equipment and materials in relationship with other systems, installations, and building components. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:

1. Indicate the proposed locations of electrical equipment, and materials. Include the following:
   a. Planned electrical systems layout, including conduit elbow radii and accessories.
   b. Clearances for servicing and maintaining electrical equipment.
   c. Exterior wall and foundation penetrations.
   d. Fire rated wall and floor penetrations.
   e. Sizes and location of required concrete pads and bases.
   f. Size and location of all electrical panels.
   g. Access doors.
2. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.
3. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations. Show all access doors for concealed junction boxes devices.
4. Prepare reflected ceiling plans to coordinate and integrate installations, air outlets and inlets, light fixtures, communication systems components, cable trays, sprinklers, access doors and other ceiling mounted items.

1.11 RECORD DOCUMENTS

A. Prepare record documents in accordance with the requirements in Division 01 Section "Contract Closeout." In addition to the requirements specified in Division 01, indicate the

following installed conditions:

1. Conduit and wire runs between the points
2. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
3. Approved substitutions, Contract Modifications, RFI responses and actual equipment and materials installed.

1.12 OPERARTION AND MAINTENANCE MANUALS

A. Electrical O & M Manual File: Provide one (1) electronic file "pdf format" for the projects Electrical Operation and Maintenance Manual for the Material and Equipment installed in the project included in Divisions 26 on a CD-R. The electronic Electrical O & M manual shall include one copy of each approved submittal, any manufacturer's maintenance manuals, all warranty certificates, arranged in file folders for each submittal. Also include the address, phone number and contact person for each supplier. Files shall be stacked and include both a book mark and tree structure for accessing each submittal file as indicated in Division 01 Section "Closeout Procedures".

A. Provide service and operating manuals for the following:

1. Division 28 Section "Digital, Addressable Fire Alarm System".

1.13 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

1.14 SEQUENCING AND SCHEDULING

A. Coordinate electrical equipment installation with other building components.

B. Arrange for chases, slots, and openings in building structure during progress of construction to allow for electrical installations.

C. Coordinate the installation of required supporting devices and set sleeves in poured in place concrete and other structural components as they are constructed.

D. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Coordinate installation of large equipment requiring positioning prior to closing in the building.

E. Coordinate connection of electrical services.

F. Coordinate connection of electrical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised

service companies, and controlling agencies.

G. Coordinate requirements for access panels and doors where electrical items requiring access are concealed behind finished surfaces. Access panels and doors are specified in the Architectural Specifications.

H. Coordinate installation of identifying devices after completing covering and painting where devices are applied to surfaces. Install identifying devices prior to installing acoustical ceilings and similar concealment.

1.15 VARIANCES

A. Where variances occur between the drawings and specifications or within either document itself, the item or arrangement of better quality, greater quantity or higher cost shall be included in the contract price. The Engineer shall decide on the item and manner in which the work shall be provided.

1.16 GUARANTEE/WARRANTY:

A. All materials, equipment, etc. provided by the general contractor and/or his subcontractors shall be guaranteed and warranted to be free from defects in workmanship and materials for a period of two (2) years after date of certificate of completion and acceptance of work by UMB. Any defects in workmanship, materials, or performance which appear within the guarantee period shall be corrected by the contractor without cost to the owner, within a reasonable time, to be specified by UMB. In default thereof, owner may have such work done and charge the cost of same to the contractor. In addition to the above statement the Guarantee/Warranty Period shall include all labor cost related to all warranty work. For compressorized equipment include an additional three (3) year Guarantee/Warranty Period.

**PART 2 - PRODUCTS**

2.1 LISTED MANUFACTURERS:

A. Listed Manufacturers: The listed manufacturers indicated in Part 2 of each specification section as the basis of design represents the minimum level of quality for materials and equipment that is acceptable to UMB. Unless otherwise indicated in each specification section, contractors may submit material and equipment by non listed manufacturers provided said submittals meet the requirements of these specifications. All submitted materials and equipment are subject to approval by the A/E and UMB.

B. Approved Equal Equipment Layouts: The equipment layouts and the related mechanical and electrical service connections, access space and supports indicated on the construction documents represent equipment provided by the specified basis of design manufacturer and model number. When the successful bidder chooses to provide “or approved equal” equipment by one (1) of the other listed manufacturers in the specifications, the bidder shall be responsible for providing all adjustments and

modifications to the services necessary to make connections to the equipment, the bidder shall be responsible for installing the equipment such that all required clear access space is maintained, and the bidder shall be responsible for providing all adjustments and modifications to the equipment mounting and supports. All adjustments and modifications shall be provided by the bidder and appropriate subcontractors at no additional cost to the project.

## PART 3 – EXECUTION

### 3.1 ROUGH-IN

A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

B. For equipment rough-in requirements see specifications for electrical equipment.

### 3.2 ELECTRICAL INSTALLATIONS

A. General: Sequence, coordinate, and integrate the various elements of electrical systems, materials, and equipment. Comply with the following requirements:

1. Coordinate electrical systems, equipment, and materials installation with other building components.
2. Verify all dimensions by field measurements.
3. Install systems, materials, and equipment to conform with approved submittal data, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to UMB.
4. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.
5. Install electrical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.
6. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

### 3.3 CUTTING AND PATCHING

A. General: Perform cutting and patching in accordance with Division 1 Section "Cutting and Patching." In addition to the requirements specified in Division 1, the following requirements apply:

1. Protection of Installed Work: During cutting and patching operations, protect adjacent installations.

B. Perform cutting, fitting, and patching of electrical equipment and materials required to:

1. Uncover Work to provide for installation of ill timed Work.
2. Remove and replace defective Work.
3. Remove and replace Work not conforming to requirements of the Contract Documents.
4. Disconnect installed work as specified for testing.
5. Install equipment and materials in existing structures.
6. Upon written instructions from UMB, uncover and restore Work to provide for UMB observation of concealed Work.

C. Cut, remove and legally dispose of selected electrical equipment, components, and materials as indicated, including but not limited to removal of electrical systems and equipment as indicated on the drawings and specifications and other electrical items made obsolete by the new Work.

D. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.

E. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.

1. Patch existing finished surfaces and building components using new materials matching existing materials and experienced Installers. Installers' qualifications refer to the materials and methods required for the surface and building components being patched.
   a. Refer to Division 01 Section "Definitions and Standards" for definition of "experienced Installer."

2. Patch finished surfaces and building components using new materials specified for the original installation and experienced Installers. Installers' qualifications refer to the materials and methods required for the surface and building components being patched.
   a. Refer to Division 01 Section "Definitions and Standards" for definition of "experienced Installer."

3.4 PROTECTION OF WORK

A. Protect work, material and equipment from weather and construction operations before and after installation.

B. Properly store and handle all materials and equipment.

C. Cover temporary openings for electrical equipment to prevent the entrance of water, dirt, debris, and other foreign matter.

3.5 PROVISIONS FOR ACCESS

A. Furnish and install adequate access to all electrical components. The following list shall be used as a guide only:

1. Equipment such as transformers, generators, etc.
2. Distribution panels.
3. Switch Gear.
4. Disconnects.
5. Variable frequency drives.

B. Access shall be as required by code and/or as determined by the Architect and Engineer.

C. Refer to contract drawings where access panels have been specifically located.

D. Where access is by means of lift out ceiling tiles or panels mark access each panel using small color coded or numbered tabs. Provide an index chart for identification. Place markers in corner of tile.

3.6 DEMONSTRATION AND INSTRUCTIONS

A. Demonstrate operation and maintenance of equipment and systems to Owner's personnel a minimum two (2) weeks prior to date of final inspection.

1. For equipment requiring seasonal operation, perform instructions for other seasons at the same time.
2. Training period shall be performed within one (1), two (2) week period.

B. Use operation and maintenance manuals and video as basis of instruction. Review contents of manual and video with personnel in detail to explain all aspects of operation and maintenance.

C. Demonstrate the following:

1. Start up.
2. Operation.
3. Control.
4. Adjustment.
5. Trouble shooting.
6. Servicing.
7. Maintenance.
8. Shutdown.

D. Provide at least forty (40) hours straight time instruction to the operating personnel.

1. This instruction period shall consist of not less than five (5) eight (8) hour days.
2. Time of instruction shall be designated by the Owner.
3. This instruction shall be in addition to instructional requirements of specific

equipment specified elsewhere in the mechanical specifications.

3.7 EQUIPMENT PROVIDED UNDER ANOTHER DIVISION AND BY OTHERS

A. The Installer of products under Divisions 26, 27, & 28 shall make all system connections required to equipment furnished and installed under another division and by others.

B. It shall be the responsibility of the Installer to obtain all necessary data from the equipment supplied under other Divisions.

3.8 RECORD DRAWINGS (As Built)

A. Upon completion of the electrical installations, the Installer shall deliver to the Architect one (1) complete set of marked-up blueprints of the electrical contract drawings.

1. The mark-ups shall be legibly marked in red pencil to show all changes and departures of the installation as compared with the original design.
2. Refer to General Requirements of Division 01 for additional requirements pertaining to Submittals and Record Drawings.

3.9 CLOSEOUT PROCEDURES

A. Operating and Maintenance Instructions: Submit Complete Package At Least Two (2) Months Prior To Substantial Completion. Arrange for each installer of equipment that requires regular maintenance to meet with the Owner's personnel to provide instruction in proper operation and maintenance. If installers are not experienced in procedures, provide instruction by manufacturer's representatives. Include a detailed review of the following items:

1. Maintenance manuals, including a customized list of preventive maintenance items and annual schedule for maintenance.
2. Record documents.
3. Complete inventory of spare parts and materials.
4. Tools.
5. Identification systems.
6. Control sequences.
7. Hazards.
8. Cleaning.
9. Warranties and bonds.
10. Maintenance agreements and similar continuing commitments.
11. Source code and software.

B. As part of instruction for operating equipment, demonstrate the following procedures:
1. Switchgear Sequence of Operations
2. Generator and Paralleling Switchgear Sequence of Operations

3.10 INSPECTIONS

A. Contractor shall:
   1. Schedule, pay for (as applicable) and attend all inspections required by the Authorities Having Jurisdiction.

   2. Deliver all certificates to the Owner prior to final acceptance of work.

B. Notify UMB in advance of scheduled inspections.

C. An electrical foreman, superintendent or other supervisor familiar with the project shall be in attendance for all scheduled electrical inspections.

D. Electrical inspection shall be by third ($3^{rd}$) Party Inspector approved by the Maryland State Fire Marshall.

E. Schedule the preliminary and rough-in inspections in a timely manner. Any work covered prior to any inspection in a manner which, in the inspector's opinion, precludes a complete inspection shall be uncovered at the installer's cost.

3.11 DEMOLITION:

A. Remove and dispose of all existing materials not required for re-use or re-installation.

B. Deliver on the premises, where directed, existing material and equipment which is to be salvaged and remain property of Owner.

C. All other materials removed shall become the property of the Contractor and shall be removed from the premises.

D. Remove conduit, hangers, supports, etc. to a point below the finished floors or behind finished walls and cap. Cut such items flush with masonry surfaces.

E. Remove wiring and conduit back to source panelboard or switch, or to last remaining device on the circuit. Remove conduit, hangers, supports, etc. unless otherwise noted. Conduit may remain to be reused for new work provided it is of the specified size and type and in condition acceptable to UMB.

F. Any conduit abandoned in concrete slabs, walls, or other inaccessible locations shall be left with a nylon pull wire. Ends shall be capped with push plugs for future use.

3.12 REPAIRS & RESTORATION OF SURFACES AND FINISHES:

A. Restore all finishes, equipment and surfaces to original condition, where affected by the work. Provide the following, where applicable, in accordance with accepted trade standards and to Owner's satisfaction:

   1. Replace damaged ceiling tiles.

2. Replace ceiling tiles where removal has left holes or cuts in original tiles.
3. Patch, repair and repaint all walls and surfaces cut, penetrated or otherwise disturbed by the work.
4. Patch holes and penetrations in wood, masonry and plaster.
5. Provide suitable cover plates for all recessed back boxes of equipment removed and not covered by new devices.
6. Provide larger trim or cover plates for new devices, where old back boxes, holes, etc. are not concealed by new work.

## 3.13 FINAL CLEANING

A. General: General cleaning during construction is required by the General Conditions and included in Section Temporary Facilities.

B. Cleaning: Switchgear and electrical equipment shall have a final cleaning within 30 days prior to substantial completion. Such cleaning shall be accomplished by an electrical testing firm experienced in servicing the equipment. Comply with manufacturer's instructions.

C. Remove all electrical clippings, wiring, nuts, bolts, etc. left on top of ceilings and ceiling tiles.

## 3.14 PROJECT PUNCH OUT

A. Architect/Engineer will perform punch out reviews and will provide the Contractor with a list of punch list items to be completed before contract close out. Each and every punch list item shall be initialed and dated by the Contractor when the work is complete. The Architect/ Engineer will not perform any punch list verification until all items have been completed, initialed, dated and the list returned to the Architect/Engineer. If any items have been initialed as being completed by the Contractor and the Architect/Engineer determines that the work is not complete, the Architect/Engineer shall be reimbursed by the Contractor at his regular hourly rate for any and all items requiring revisiting of the site by the Architect/Engineer. Reimbursement shall be made by deducting the Architect/Engineer fee from the Contractor's final payment.

END OF SECTION 260000

# SECTION 260513 - MEDIUM-VOLTAGE CABLES

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 26.

### 1.2 SUMMARY

A. This Section includes cables and related splices, terminations, accessories and acceptance testing for 15,000 volt electrical distribution systems.

### 1.3 DEFINITIONS

A. NETA ATS: Acceptance Testing Specification.

### 1.4 SUBMITTALS

A. General: Submit the following according to the Conditions of the Contract and Division 1 Specification Sections.

B. Product Data: For each type of cable indicated. Include splices and terminations for cables and cable accessories.

C. Samples: Sixteen (16) inch lengths of each type of cable indicated.

D. Qualification Data: For Installer and testing agency. Data submitted shall confirm that the person(s) and firm(s) listed in the "Quality Assurance" Article have demonstrated their capabilities and experience. The data shall include, but limited to a list of completed projects with project names, addresses, names of Architects and UMBs. Additional data includes:

E. Material Certificates: For each cable and accessory type, signed by manufacturers.

F. Source quality-control test reports. Certified reports of manufacturer’s design and production tests indicating compliance of cable and accessories with reference standards.

G. Field quality-control test reports. Field test reports indicating and interpreting test results relative to compliance with performance requirements specified. Include certified copies of field test reports.

H. Installation Manual: Manual shall include all data relative to installing the cables and accessories. Maximum pulling tensions, side wall pressure limitations, type of pulling devices shall all be documented within the manual.

I. Operation & Maintenance Manual: Include recommendation relating to acceptance and periodic maintenance testing and infrared scanning photometry. Recommendation shall include frequency and type of testing. Operation data shall include data of fault indicators and separable connectors and their accessories.

## 1.5 QUALITY ASSURANCE

A. Installer: Engage a cable splicer, trained and certified by splice material manufacturer, to install, splice, and terminate medium-voltage cable. Submit the following within 30-days of contract award:

1. Name of individual(s) performing splicing/terminating
2. Certification of individual performing test with name and date
3. Number of years of medium voltage splicing/terminating experience
4. Proof of termination/splice of the type to be installed, under supervision of the kit manufacturer, or representative
5. Dummy splice/termination successfully tested as follows. Test to be performed by the splice kit supplier.

| Test | Minimum Value |
|---|---|
| Discharge Ext. Value with, 3 pcs. | 13-kV |
| Ac Withstand, 1 minute | 35-kV |
| DC Withstand, 15 minutes | 65-kV |

6. List of three recent jobs within last twelve (12) months where specific splices/terminations were installed. Include splice/termination manufacturer, catalogue number, cable type and the quantity installed.

B. Manufacturer Qualifications: Firm experienced in manufacturing medium-voltage cable and accessories similar to those indicated for this project, with a ten (10) year record of successful in-service performance

C. Testing Agency Qualifications: In addition to the requirements specified in Division 1 Section "Quality Control Services," an independent testing agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing

laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

D. Source Limitations: Obtain cables and accessories through one source from a single manufacturer.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

F. Comply with IEEE C2 "National Electrical Safety Code" and NFPA 70.

G. Production Tests shall be performed on the cable at time of manufacture.

1. Resistance requirements of ICEA S-68-516, section 2.5.
2. Insulation resistance test shall be performed in accordance with ICEA S-68-516, part 6.28, and shall have an insulation resistance constant of at least 50,000 megohms-1000 feet at $15^0$C.
3. A high voltage ac and dc test shall be performed in accordance with part 6.27 of ICEA S-68-516. The test voltage shall be as follows:

| Insulation | Wall | AC kV (5 Minutes) | DC kV (15 minutes) |
|---|---|---|---|
| 115 | 23 | 45 | |
| 220 | 44 | 80 | |

4. The shield resistance shall be measured and recorded from end top end on the complete cable
5. The cable shall be corona discharge tested in accordance with Section G of AEIC CS^. The maximum allowable discharge is five (5) picocoulombs throughout the entire specified test voltage range.
6. Certified test reports shall be furnished to the Engineer, for review, for all cables prior to installation.

## 1.6 PROJECT CONDITIONS

A. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by UM or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify UM in writing no fewer than ten (10) days in advance of proposed interruption of electric service.

2. Do not proceed with interruption of electric service without written permission from – UMB PM.

3. Outages to existing loads shall occur during off hours.

   a. If contractor elects to do outages or switchovers during normal hours then contractor shall submit a plan to be approved by the owner and provide temporary power at no additional cost.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver medium voltage cable on factory reels conforming to NEMA WC 26.

B. Store cables on reels on elevated platforms in a dry location.

C. Provide hot–shrink (cold-shrink not permitted) cable end caps for cable stored outside.

1.8 WARRANTY/GUARANTEE

A. See Division 26 Specification Section “Basic Electrical Requirements’ for warranty and guarantee requirements.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. Cables:

   a. General Cable Technologies Corporation.
   b. Okonite Company (The).
   c. Pirelli Cables & Systems NA.
   d. Rome Cable Corporation.
   e. Southwire Company.

2. Cable Splicing and Terminating Products and Accessories:

   a. G&W Electric Company.
   b. Raychem Corp.; Telephone Energy and Industrial Division; Tyco International Ltd.
   c. RTE Components; Cooper Power Systems, Inc.
   d. Thomas & Betts Corporation/Elastimold.

e. 3M; Electrical Products Division.
f. Approved Equal.

3. Arc Proofing Products:

a. 3M/ Scotch Products.
b. Plymoth Bishop
c. Thomas and Betts Corporation

2.2 CABLES

A. Cable Type: MV105, single conductor insulated power cable.

B. Comply with UL 1072, AEIC CS 8, ICEA S-93-639, and ICEA S-97-682, ASTM B-8 or B-231.

C. Conductor: Copper.

D. Conductor Stranding: Compact round, concentric lay, Class B.

E. Conductor Insulation: Ethylene-propylene rubber (EPR) conforming to NEMA WC74 (ICEA S-68-516 and AEIC CS6).

1. Voltage Rating: 15 kV.
2. Insulation Thickness: 133 percent insulation level.

F. Shielding: Copper tape, helically applied over semiconducting insulation shield.
1. 25% tape overlay

G. Shielding and Jacket: Corrugated copper drain wires embedded in extruded, chlorinated, polyethylene jacket.

2.3 SPLICE KITS

A. Connectors and Splice Kits: Comply with IEEE 404; type as recommended by cable or splicing kit manufacturer for the application.

B. Splicing Products: As recommended, in writing, by splicing kit manufacturer for specific sizes, ratings, and configurations of cable conductors. Include all components required for complete splice, with detailed instructions.

1. Heat-shrink splicing kit of uniform, cross-section, polymeric construction with outer heat-shrink jacket.

## 2.4 SOLID TERMINATIONS

A. Shielded-Cable Terminations: Comply with the following classes of IEEE 48. Insulation class is equivalent to that of cable. Include shield ground strap for shielded cable terminations.

1. Class 1 Terminations: Modular type, furnished as a kit, with stress-relief tube; multiple, molded-silicone rubber, insulator modules; shield ground strap; and compression-type connector.
2. Class 1 Terminations: Heat-shrink type with heat-shrink inner stress control and outer nontracking tubes; multiple, molded, nontracking skirt modules; and compression-type connector.
3. Class 1 Terminations: Modular type, furnished as a kit, with stress-relief shield terminator; multiple-wet-process, porcelain, insulator modules; shield ground strap; and compression-type connector.
4. Class 1 Terminations, Indoors: Kit with stress-relief tube, nontracking insulator tube, shield ground strap, compression-type connector, and end seal.

## 2.5 SEPARABLE INSULATED CONNECTORS

A. Description: Modular system, complying with IEEE 386, with disconnecting, single-pole, cable terminators and with matching, stationary, plug-in, dead-front terminals designed for cable voltage and for sealing against moisture.

B. Terminations at Distribution Points: Modular type, consisting of terminators installed on cables and modular, dead-front, terminal junctions for interconnecting cables.

C. Load-Break Cable Terminators: Elbow-type units with 200-A load make/break and continuous-current rating; coordinated with insulation diameter, conductor size, and material of cable being terminated. Include test point on terminator body that is capacitance coupled.

D. Dead-Break Cable Terminators: Elbow-type unit with 600-A continuous-current rating; designed for de-energized disconnecting and connecting; coordinated with insulation diameter, conductor size, and material of cable being terminated. Include test point on terminator body that is capacitance coupled.

E. Dead-Front Terminal Junctions: Modular bracket-mounted groups of dead-front stationary terminals that mate and match with above cable terminators. Two-, three-, or four-terminal units as indicated, with fully rated, insulated, watertight conductor connection between terminals and complete with grounding lug, manufacturer's standard accessory stands, stainless-steel mounting brackets, and attaching hardware.

1. Protective Cap: Insulating, electrostatic-shielding, water-sealing cap with drain wire.

2. Portable Feed-Through Accessory: Two-terminal, dead-front junction arranged for removable mounting on accessory stand of stationary terminal junction.
3. Grounding Kit: Jumpered elbows, portable feed-through accessory units, protective caps, test rods suitable for concurrently grounding three phases of feeders, and carrying case.
4. Standoff Insulator: Portable, single dead-front terminal for removable mounting on accessory stand of stationary terminal junction. Insulators suitable for fully insulated isolation of energized cable-elbow terminator.

F. Test-Point Fault Indicators: Applicable current-trip ratings and arranged for installation in test points of load-break separable connectors, and complete with self-resetting indicators capable of being installed with shotgun hot stick and tested with test tool.

G. Tool Set: Shotgun hot stick with energized terminal indicator, fault-indicator test tool, ground cable set and carrying case.

## 2.6 FAULT INDICATORS

A. Indicators: Manually reset fault indicator with inrush restraint feature, arranged to clamp to cable sheath and provide a display after a fault has occurred in cable. Instrument shall not be affected by heat, moisture, and corrosive conditions and shall be recommended by manufacturer for installation conditions.

B. Resetting Tool: Designed for use with fault indicators, with moisture-resistant storage and carrying case.

## 2.7 PROTECTIVE CABLE END CAPS

A. Protect MV cables from water penetration on job site, before, during and after cable pulling. Seal cable end with heat-shrinkable end cap. This cap will remain in place until the actual time of termination. Sealing compounds and/or taping shall not constitute acceptable environmental protection. End sealing caps shall be as produced by Raychem Corporation, Type ESC, or equal.

## 2.8 ARC-PROOFING MATERIALS

A. Tape for First Course on Metal Objects: 10-mil- thick, corrosion-protective, moisture-resistant, PVC pipe-wrapping tape.

B. Arc-Proofing Tape: Fireproof tape, flexible, conformable, intumescent to 0.3 inch thick, compatible with cable jacket.

C. Glass-Cloth Tape: Pressure-sensitive adhesive type, 1/2 inch wide.

2.9 SOURCE QUALITY CONTROL

A. Test and inspect cables according to ICEA S-97-682, NEMA WC74 before shipping.

## PART 3 - EXECUTION

3.1 INSTALLATION

A. Install cables according to manufacturer's written instructions and IEEE 576.

B. Pull Conductors: Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

1. Where necessary, use NRTL - listed and manufacturer-approved pulling compound or lubricant that will not deteriorate conductor or insulation.
2. Use pulling means, including fish tape, cable, rope, and basket-weave cable grips that will not damage cables and raceways. Do not use rope hitches for pulling attachment to cable.
3. Provide written calculations confirming pulling tensions and side wall pressure limits are within cable manufacturer's recommendations. Submit to Engineer prior to start of work.

C. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.

D. Install "buried-cable" warning tape twelve (12) inches above cables.

E. Install fault indicators on each phase where indicated.

F. In manholes, hand holes, pull boxes, junction boxes, and cable vaults, train cables around walls by the longest route from entry to exit and support cables at intervals adequate to prevent sag.

G. Install cable splices at pull points and elsewhere as indicated; use standard kits.

H. Install terminations at ends of conductors with standard kits.

I. Install separable insulated-connector components as follows:

1. Protective Cap: At each terminal junction, with one on each terminal to which no feeder is indicated to be connected.
2. Portable Feed-Through Accessory: Three.
3. Standoff Insulator: Three.

J. Arc Proofing: Unless otherwise indicated, arc proof medium-voltage cable at locations not protected by conduit, cable tray, direct burial, or termination materials. In addition to arc-proofing tape manufacturer's written instructions, apply arc proofing as follows:

1. Clean cable sheath.
2. Wrap metallic cable components with 10-mil pipe-wrapping tape.
3. Smooth surface contours with electrical insulation putty.
4. Apply arc-proofing tape in one half-lapped layer with coated side toward cable.
5. Band arc-proofing tape with one (1) inch- wide bands of half-lapped, adhesive, glass-cloth tape two (2) inches o.c.

K. Ground shields of shielded cable at terminations, splices, and separable insulated connectors. Ground metal bodies of terminators, splices, cable and separable insulated-connector fittings, and hardware.

L. Identify cables according to Division 26 Section "Identification for Electrical Systems."

M. Prior to installing cables, pull a mandrel sized 1/4" less than conduit ID. Then clean each conduit with a stiff brush to remove debris.

N. Use pulling means including, fish tape, cable, rope, basket-weave wire/cable grips and pulling eyes that will not damage cable or raceways. Do not use rope hitches for pulling attachments to cable.

## 3.2 FIELD QUALITY CONTROL

A. Tests and Inspections: Engage an independent, testing and inspecting agency to perform the following field tests and inspections and prepare test reports at no additional cost to UM:

1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS and in the presence of UM personnel or authorized agent. Certify compliance with test parameters.
2. After installing medium-voltage cables and before electrical circuitry has been energized, test for compliance with requirements.

    a. VLF high potential per IEEE 400.2-2004
    b. Shield Continuity
    c. Provide live phasing test to ensure redundant feeders are phased and synchronized
    d. If installed cable is being spliced to an existing cable, VLF Hi-Pot test shall be performed prior to it being spliced. Temporary terminations shall be used where appropriate. After splicing is complete, testing shall be performed as indicated above.

3. Infrared Scanning: After Substantial Completion, but not more than sixty (60) days after Final Acceptance, perform an infrared scan of each splice in cables and conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner. The infrared testing shall be performed by minimum Level 1 infrared certified thermographer.

    a. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice eleven (11) months after date of Substantial Completion.
    b. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
    c. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken and observations after remedial action.

B. Test Reports: Prepare a written report to record the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

C. Remove and replace malfunctioning units and retest as specified above, listing all deficiencies and corrective actions.

END OF SECTION 260513

# SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 26.

### 1.2 SUMMARY

A. This Section includes the following:

1. Building wires and cables rated 600 V and less.
2. Connectors, splices, and terminations rated 600 V and less.
3. Sleeves and sleeve seals for cables.

### 1.3 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

B. NBR: Acrylonitrile-butadiene rubber.

### 1.4 SUBMITTALS

A. General: Submit the following according to the Conditions of the Contract and Division 1 Specification Sections.

B. Product Data: For each type of product indicated.

C. Qualification Data: For testing agency.

D. Field quality-control test reports.

E. Operation and Maintenance materials.

## 1.5 PROJECT CONDITIONS

A. Interruption of Existing electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify UM no fewer than 10 days in advance of proposed interruption of electric service.
2. Do not proceed with interruption of electric service without UM's written permission.
3. Outages to existing loads shall occur during off hours.
    a. If contractor elects to do outages or switchovers during normal hours then contractor shall submit a plan to be approved by the owner and provide temporary power at no additional cost.

## 1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70.

## 1.7 COORDINATION

A. Set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

## 1.8 WARRANTY/GUARANTEE

A. See Division 26 Specification Section "Basic Electrical Requirements' for warranty and guarantee requirements.

## PART 2 - PRODUCTS

### 2.1 CONDUCTORS AND CABLES

A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. Alcan Products Corporation; Alcan Cable Division.
2. American Insulated Wire Corp.; a Leviton Company.
3. General Cable Corporation.
4. Senator Wire & Cable Company.
5. Southwire Company.
6. The Okonite Company.
7. Belden, Inc.

B. Copper Conductors: Comply with NEMA WC 70.

C. Conductor Insulation: Comply with NEMA WC 70 for Types THHN-THWN-2 and XHHW-2.

D. Multiconductor Cable: Comply with NEMA WC 70 for steel-clad cable, Type MC with ground wire.
1. Fittings: Steel

E. Color Coding:

| **208/120 Volts** | | **480/277 Volts** | |
|---|---|---|---|
| **Phase** | **Color** | **Phase** | **Color** |
| A | Black | A | Brown |
| B | Red | B | Orange |
| C | Blue | C | Yellow |
| Neutral | White | Neutral | Gray |
| Ground | Green | Ground | Green |

### 2.2 CONNECTORS AND SPLICES

A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. AFC Cable Systems, Inc.
2. Hubbell Power Systems, Inc.
3. O-Z/Gedney; EGS Electrical Group LLC.
4. 3M; Electrical Products Division.
5. Tyco Electronics Corp.

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

2.3 SLEEVES FOR CABLES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

C. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.052- or 0.138-inch thickness as indicated and of length to suit application.

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

2.4 SLEEVE SEALS

A. Basis-of-Design Product: Subject to compliance with requirements, provide a comparable product by one (1) of the following:

1. Advance Products & Systems, Inc.
2. Calpico, Inc.
3. Metraflex Co.
4. Pipeline Seal and Insulator, Inc.

B. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.

1. Sealing Elements: NBR interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
2. Pressure Plates: Stainless steel. Include two for each sealing element.
3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

**PART 3 - EXECUTION**

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

## 3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance and conductors #4/0 and larger: Type XHHW-2, single conductors in raceway.

B. Feeders smaller than #4/0: Type THHN-THWN-2, single conductors in raceway.

C. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type XHHW-2, single conductors in raceway.

D. Branch Circuits in Cable Tray: Type THHN-THWN-2, single conductors in raceway or steel-clad cable, Type MC.

E. Class 1 Control Circuits: Type THHN-THWN-2, in raceway.

F. Class 2 Control Circuits: Type THHN-THWN-2, in raceway.

## 3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.

B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage cables or raceway.

D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

E. Support cables according to Division 26 Section "Hangers and Supports for Electrical Systems."

F. Identify and color-code conductors and cables according to Division 26 Section "Identification for Electrical Systems."

G. MC Cable Installation Requirements:
   1. Install in compliance with NFPA 70.
   2. Locations: In dry wall partitions and above accessible ceilings. Do not install in masonry partitions or walls.

3. Independently support all MC Cable runs; do not piggy-back on plumbing/HVAC, lighting fixture, and/or ceiling grid supports.
4. Do not bundle more than three (3) runs together for supporting purposes.
5. MC cable shall be installed in a neat and orderly fashion using batwings type supports.
6. Minimum bend radius shall be as recommended by the manufacturer.
7. MC cable run to switches shall have a neutral conductor.
8. Cable larger than #8AWG shall not be permitted.
9. All acceptable homeruns from panels in electrical rooms shall be installed in EMT conduit to a junction box/wire trough outside electrical rooms in accessible ceiling of corridor.
10. Homeruns from panelboard to junction box outside of electrical room: wire in EMT or IMC raceway.
11. Do NOT run MC Cable in exposed locations (e.g. all open ceiling locations, Mechanical and Electrical Equipment Rooms, IT Rooms, etc.).
12. MC cable shall be secured at intervals not exceeding six (6) feet and within twelve (12) inches of every outlet box or fitting. Luminaire whips may be six (6) feet maximum without support.

## 3.4 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 12 inches of slack.

## 3.5 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Rectangular Sleeve Minimum Metal Thickness:

1. For sleeve rectangle perimeter less than fifty (50) inches and no side greater than 16 inches, thickness shall be 0.052 inch.

2. For sleeve rectangle perimeter equal to, or greater than, fifty (50) inches and one (1) or more sides equal to, or greater than, sixteen (16) inches, thickness shall be 0.138 inch.

E. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

F. Cut sleeves to length for mounting flush with both wall surfaces.

G. Extend sleeves installed in floors three (3) inches above finished floor level.

H. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and cable unless sleeve seal is to be installed or unless seismic criteria require different clearance.

I. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.

J. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and cable, using joint sealant appropriate for size, depth, and location of joint according to Division 07 Section "Joint Sealants."

K. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at cable penetrations. Install sleeves and seal with firestop materials according to Division 07 Section "Penetration Firestopping."

L. Roof-Penetration Sleeves: Seal penetration of individual cables with flexible boot-type flashing units applied in coordination with roofing work.

M. Aboveground Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Size sleeves to allow for one (1) inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

N. Underground Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for one (1) inch annular clear space between cable and sleeve for installing mechanical sleeve seals.

## 3.6 SLEEVE-SEAL INSTALLATION

A. Install to seal underground exterior-wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for cable material and size. Position cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

## 3.7 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Division 07 Section "Penetration Firestopping."

## 3.8 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.

B. Perform tests and inspections and prepare test reports.

C. Tests and Inspections:

1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors, and conductors feeding the following critical equipment and services for compliance with requirements.

    a. Switchgear Battery Chargers

    b. Mechanical HVAC equipment

2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

3. Infrared Scanning: After Substantial Completion, but not more than sixty (60) days after Final Acceptance, perform an infrared scan of each splice in cables and conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner. The infrared testing shall be performed by minimum Level 1 infrared certified thermographer.

4.

    a. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice eleven (11) months after date of Substantial Completion.
    b. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
    c. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken and observations after remedial action.

D. Test Reports: Prepare a written report to record the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

E. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 260519

# SECTION 260523 - CONTROL-VOLTAGE ELECTRICAL POWER CABLES

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 26.

### 1.2 SUMMARY

A. Section Includes:

1. UTP cabling.
2. 62.5/125-micrometer, multimode optical fiber cabling.
3. RS-485 cabling.
4. Low-voltage control cabling.
5. Control-circuit conductors.
6. Identification products.

### 1.3 DEFINITIONS

A. Basket Cable Tray: A fabricated structure consisting of wire mesh bottom and side rails.

B. Channel Cable Tray: A fabricated structure consisting of a one (1) piece, ventilated-bottom or solid-bottom channel section.

C. EMI: Electromagnetic interference.

D. IDC: Insulation displacement connector.

E. Ladder Cable Tray: A fabricated structure consisting of two longitudinal side rails connected by individual transverse members (rungs).

F. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.

G. Open Cabling: Passing telecommunications cabling through open space (e.g., between the studs of a wall cavity).

H. RCDD: Registered Communications Distribution Designer.

I. Solid-Bottom or Nonventilated Cable Tray: A fabricated structure consisting of integral or separate longitudinal side rails, and a bottom without ventilation openings.

J. Trough or Ventilated Cable Tray: A fabricated structure consisting of integral or separate longitudinal rails and a bottom having openings sufficient for the passage of air and using 75 percent or less of the plan area of the surface to support cables.

K. UTP: Unshielded twisted pair.

## 1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:

1. Vertical and horizontal offsets and transitions.
2. Clearances for access above and to side of cable trays.
3. Vertical elevation of cable trays above the floor or bottom of ceiling structure.
4. Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.

C. Qualification Data: For qualified layout technician, installation supervisor, and field inspector.

D. Source quality-control reports.

E. Field quality-control reports.

F. Maintenance Data: For wire and cable to include in maintenance manuals.

## 1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 450 or less.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.
   1. Test optical fiber cable on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector; include the loss value of each. Retain test data and include the record in maintenance data.
   2. Test each pair of UTP cable for open and short circuits.

B. PROJECT CONDITIONS

C. Environmental Limitations: Do not deliver or install UTP and optical fiber cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.7 WARRANTY/GUARANTEE

A. See Division 26 Specification Section “Basic Electrical Requirements’ for warranty and guarantee requirements.

**PART 2 - PRODUCTS**

2.1 PATHWAYS

A. Support of Open Cabling: NRTL labeled for support of Category 6 cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.

   1. Velcro straps.
   2. J-hooks.

B. Cable Trays:

   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

      a. Cable Management Solutions, Inc.
      b. Chatsworth Products Inc.
      c. Cablofil Inc.

d. Cooper B-Line, Inc.
e. Cope - Tyco/Allied Tube & Conduit.

2. Cable Tray Materials: Metal, suitable for indoors and protected against corrosion by hot-dip galvanizing, complying with ASTM A 123/A 123M, Grade 0.55, not less than 0.002165 inch thick steel, steel wire mesh or aluminum.

a. Basket Cable Trays: six (6) inches wide and two (2) inches deep. Wire mesh spacing shall not exceed two (2) by four (4) inches.
b. Trough or Ventilated Cable Trays: six (6) inches wide.
c. Ladder Cable Trays: six (6) inches wide, and a rung spacing of nine (9) inches.

C. Conduit and Boxes: Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems."

1. Outlet boxes shall be no smaller than two (2) inches wide, three (3) inches high and two and one quarter (2-1/2) inches deep.

## 2.2 BACKBOARDS

A. Description: Plywood, fire-retardant treated, three quarters (3/4) inches by forty eight (48) inches by ninety six (96) inches. Comply with requirements for plywood backing panels in Division 06 Section "Rough Carpentry."

## 2.3 UTP CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. Belden CDT Inc.; Electronics Division.
2. Berk- Tek; a Nexans company.
3. CommScope, Inc.
4. Mohawk; a division of Belden CDT.
5. Superior Essex Inc.
6. General Cable Company.
7. Siemon

B. Description: 22-24 AWG, solid copper conductors, 100- ohm, four (4) pair UTP, nominal impedance +/- 15%, green CMP Plenum jacket and complies with EIA/TIA 568-C Cat 6 standard
1. Comply with ICEA S-90-661 for mechanical properties.
2. Comply with TIA/EIA-568-C, Category 6.
3. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:

a. Communications, Plenum Rated: Type CMP, complying with NFPA 262.

## 2.4 UTP CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. Ortronics Corporation
2. Siemon Co. (The).

B. UTP Cable Connecting Hardware: IDC type, using modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of the same manufacturer and the same category or higher.

C. Connecting Blocks: 110 style for Category 6. Provide blocks for the number of cables terminated on the block, plus 25% spare; integral with connector bodies, including plugs and jacks where indicated.

## 2.5 OPTICAL FIBER CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. Corning
2. SYSTIMAX Solutions; a CommScope, Inc. brand.
3. Optical Cable Corporation Lucent/Abaya

B. Description: Multimode, 62.5/125-micrometer, 12-fiber, nonconductive, tight buffer, OM1, optical fiber cable. Single mode, 9/125-micrometer, 12-fiber, plenum-rated, optical fiber cable.

1. Comply with ICEA S-83-596 for mechanical properties.
2. Comply with TIA/EIA-568-C for performance specifications.
3. Comply with TIA/EIA-492AAAA-A for detailed specifications.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:

   a. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.

5. Maximum Attenuation: 3.50dB/km at 850 nm; 1.0dB/km at 1300 nm for OM1 multimode, 1.0 dB/km at 1310 nm; 1.0 dB/km at 1550 nm for single mode.
6. Minimum Modal Bandwidth: 200 MHz-km at 850 nm; 500 MHz-km at 1300 nm for OM1 multimode.

C. Jacket:

1. Jacket Color: Orange for multimode and yellow for single mode.
2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA/EIA-598-C.
3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed forty (40) inches.

## 2.6 OPTICAL FIBER CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Berk-Tek; a Nexans company.
2. Corning Cable Systems.
3. Siemon Co. (The).

B. Cable Connecting Hardware:

1. Comply with the Fiber Optic Connector Intermateability Standards (FOCIS) specifications of TIA/EIA-604-2, TIA/EIA-604-3-A, and TIA/EIA-604-12. Comply with TIA/EIA-568-B.3.
2. Quick-connect, simplex and duplex, Type SC connectors. Insertion loss not more than 0.5 dB.

## 2.7 RS-485 CABLE

A. Standard Cable: NFPA 70, Type CM.

1. Paired, two pairs, twisted, No. 22 AWG, stranded (7x30) tinned-copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with UL 1581.

B. Plenum-Rated Cable: NFPA 70, Type CMP.

1. Paired, two pairs, No. 22 AWG, stranded (7x30) tinned-copper conductors.
2. Fluorinated ethylene propylene insulation.
3. Unshielded.
4. Fluorinated ethylene propylene jacket.
5. Flame Resistance: NFPA 262, Flame Test.

## 2.8 LOW-VOLTAGE CONTROL CABLE

A. Paired Cable: NFPA 70, Type CMG.

1. One pair, twisted, No. 16 AWG, stranded (19x29) tinned-copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with UL 1581.

B. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.

1. One pair, twisted, No. 16 AWG, stranded (19x29) tinned-copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with NFPA 262.

## 2.9 CONTROL-CIRCUIT CONDUCTORS

A. Class 1 Control Circuits: Stranded copper, Type THHN-THWN, in raceway, complying with UL 83.

B. Class 2 Control Circuits: Stranded copper, Type THHN-THWN, in raceway, complying with UL 83.

C. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type TW or Type TF, complying with UL 83.

## 2.10 GROUNDING

A. Comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.

B. Comply with requirements of NFPA 70, NEC, National Electrical Code.

## 2.11 IDENTIFICATION PRODUCTS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Brady Corporation.
2. HellermannTyton.

3. Kroy LLC.
4. Panduit Corp.

B. Comply with UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

C. Comply with requirements in Division 26 Section "Identification for Electrical Systems."

2.12 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test UTP and optical fiber cables on reels according to TIA/EIA-568-B.1.

C. Factory test UTP cables according to TIA/EIA-568-B.2.

D. Factory test multimode optical fiber cables according to TIA/EIA-526-14-A and TIA/EIA-568-B.3.

E. Cable will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports, including all deficiencies and corrective measures.

**PART 3 - EXECUTION**

3.1 WIRING METHODS

A. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters. Conceal raceway and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with requirements for raceways and boxes specified in Division 26 Section "Raceway and Boxes for Electrical Systems."

B. Wiring within Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools to comply with manufacturer’s recommendations.

3.2 INSTALLATION OF PATHWAYS

A. Cable Trays: Comply with NEMA VE 2 and TIA/EIA-569-B-2006.

B. Comply with requirements for demarcation point, pathways, cabinets, and racks specified in Division 27 Section "Communications Equipment Room Fittings." Drawings indicate general arrangement of pathways and fittings.

C. Comply with TIA/EIA-569-B-2004 for pull-box sizing and length of conduit and number of bends between pull points.

D. Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems" for installation of conduits and wire ways.

E. Install manufactured conduit sweeps and long-radius elbows whenever possible.

F. Pathway Installation in Communications Equipment Rooms:

1. Position conduit ends adjacent to a corner on backboard where a single piece of plywood is installed, or in the corner of room where multiple sheets of plywood are installed around perimeter walls of room.
2. Install vertical and horizontal cable trays to route cables if conduits cannot be located in these positions.
3. Secure conduits to backboard when entering room from overhead.
4. Extend conduits three (3) inches above finished floor.
5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

G. Backboards: Install backboards with ninety six (96) inch dimension vertical. Butt adjacent sheets tightly and form smooth gap-free corners and joints.

## 3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Comply with NECA 1-2010.

B. General Requirements for Cabling:

1. Comply with TIA/EIA-568-C.
2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
3. Install 110-style IDC termination hardware unless otherwise indicated. Terminate conductors; no cable shall contain un-terminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
4. Cables may not be spliced.
5. Secure and support cables at intervals not exceeding thirty (30) inches and not more than six (6) inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
6. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install distribution spools.

7. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Do not allow un-terminated cable to lay on floor, prior to installation. Remove and discard cable if damaged prior to and/or during installation and replace it in its entirety with new cable.
8. Cold-Weather Installation: Bring cable to room temperature before de-reeling. Heat lamps shall not be used for heating. In the communications equipment room, install a ten (10) foot long service loop in the cable tray, on the backboard or on each end of cable.

9. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, and “Pulling Cable." Monitor cable pull tensions and ensure manufacturer’s specified tension limits are not exceeded.

C. UTP Cable Installation:

1. Comply with TIA/EIA-568-B.2.
2. Install 110-style IDC termination hardware unless otherwise indicated.
3. Do not untwist UTP cables more than one half (1/2) inch from the point of termination to maintain cable geometry.

D. Installation of Control-Circuit Conductors:

1. Install wiring in raceways. Comply with requirements specified in Division 26 Section "Raceway and Boxes for Electrical Systems."

E. Optical Fiber Cable Installation:

1. Comply with TIA/EIA-568-B.3.
2. Cable shall be terminated on connecting hardware that is rack or cabinet mounted.

F. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend copper cable not in a wireway or pathway a minimum of eight (8) inches above ceilings by cable supports not more than sixty (60) inches apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

G. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA/EIA-569-A recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.

2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: A minimum of five (5) inches.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of twelve (12) inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of twenty four (24) inches.

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: A minimum of two and one half (2-1/2) inches.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of six (6) inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of twelve (12) inches.

4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of three (3) inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of six (6) inches.

5. Separation between Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of forty eight (48) inches.
6. Separation between Cables and Fluorescent Fixtures: A minimum of five (5) inches.

## 3.4 CONTROL-CIRCUIT CONDUCTORS

A. Minimum Conductor Sizes:

1. Class 1 remote-control and signal circuits, No 14 AWG.
2. Class 2 low-energy, remote-control, and signal circuits, No. 16 AWG.
3. Class 3 low-energy, remote-control, alarm, and signal circuits, No 12 AWG.

3.5 FIRESTOPPING

A. Comply with requirements in Division 07 Section "Penetration Firestopping."

B. Comply with TIA/EIA-569-A, Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.6 GROUNDING

A. For data communication wiring, comply with ANSI-J-STD-607-A and with BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. For low-voltage wiring and cabling, comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems."

3.7 IDENTIFICATION

A. Identify system components, wiring, and cabling according to TIA/EIA-606-A. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.8 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Visually inspect UTP and optical fiber cable jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA/EIA-568-B.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Test UTP cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not after cross connection.

    a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement

Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

4. Optical Fiber Cable Tests:

   a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
   b. Link End-to-End Attenuation Tests:

      1) Multimode Link Measurements: Test at 850 or 1300 nm in one direction according to TIA/EIA-526-14-A, Method B, one Reference Jumper.
      2) Attenuation test results for links shall be less than 2.0 dB. Attenuation test results shall be less than that calculated according to equation in TIA/EIA-568-B.1.

D. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.

E. End-to-end cabling will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

END OF SECTION 260523

# SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 26.

### 1.2 SUMMARY

A. Section includes grounding systems and equipment, plus the following special applications:
   1. Underground distribution grounding.
   2. Ground bonding common with lightning protection system.

### 1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Informational Submittals: Plans showing dimensioned as-built locations of grounding features specified in "Field Quality Control" Article, including the following:

   1. Test wells.
   2. Ground rods.
   3. Ground rings.
   4. Grounding arrangements and connections for separately derived systems.
   5. Grounding for sensitive electronic equipment, i.e., computer and office equipment.
   6. Grounding for UPS', batteries and related equipment.
   7. Grounding for Generators, transfer switches and related equipment.
   8. Grounding for HVAC, pumps and related equipment.
   9. Grounding for Lightning Protection System.

C. Qualification Data: For qualified testing agency and testing agency's field supervisor.

D. Field quality-control reports.

E. Operation and Maintenance Data: In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Instructions for periodic testing and inspection of grounding features at test wells, ground rings, and grounding connections for separately derived systems shall be based on NFPA 70B.

    a. Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.
    b. Include recommended testing intervals.

1.4 QUALITY ASSURANCE

A. Independent Testing Agency Qualifications: Member Company of NETA or an NRTL.

    1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with UL 467 for grounding and bonding materials and equipment.

1.5 WARRANTY/GUARANTEE

A. See Division 26 Specification Section “Basic Electrical Requirements’ for warranty and guarantee requirements.

**PART 2 - PRODUCTS**

2.1 CONDUCTORS

A. Insulated Conductors: Copper or Tinned-copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:

    1. Solid Conductors: ASTM B 3.
    2. Stranded Conductors: ASTM B 8.
    3. Tinned Conductors: ASTM B 33.
    4. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
    5. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; one and five eights (1-5/8) inches wide and one sixteenth (1/16) inch thick.

6. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; one and five eights (1-5/8) inches wide and one sixteenth (1/16) inch thick.

C. Grounding Bus: Predrilled rectangular bars of annealed copper, one quarter (1/4) by four (4) inches in cross section, with nine thirty seconds (9/32) inch holes spaced one and one eighth (1-1/8) inches apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5000 V.

2.2 CONNECTORS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, pressure type with at least two bolts.

1. Pipe Connectors: Clamp type, sized for pipe.

C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

D. Bus-bar Connectors: Mechanical type, cast silicon bronze, solderless compression -type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

2.3 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel; three quarter (3/4) inch in diameter by ten (10) feet long.

**PART 3 - EXECUTION**

3.1 APPLICATIONS

A. Equipment Grounding Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.

B. Grounding Electrode Conductors: Install bare tinned copper conductor, No. 2/0 AWG minimum.

C. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal

inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.

D. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.

1. Install bus on insulated spacers two (2) inches minimum from wall, six (6) inches above finished floor unless otherwise indicated.
2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down to specified height above floor; connect to horizontal bus.

E. Ground Ring: Install a ground ring around the perimeter of the building or structure. Bond the ring in accordance with the National Electrical Code.

F. Concrete Encase Electrode: Install a concrete encased electrode as part of the building's or structure's foundation. Bond the electrode in accordance with the National Electrical Code.

G. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.

## 3.2 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

A. Comply with IEEE C2 grounding requirements.

B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so four (4) inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from two (2) inches above to six (6) inches below concrete. Seal floor opening with waterproof, nonshrink grout. Exposed grounding conductors pulled through manholes shall also be bonded to the ground rod in each manhole.

C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or

plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields according to written instructions by manufacturer of splicing and termination kits.

D. Pad-Mounted Transformers and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than six (6) inches from the foundation.

## 3.3 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:

1. Feeders and branch circuits.
2. Lighting circuits.
3. Receptacle circuits.
4. Single-phase motor and appliance branch circuits.
5. Three-phase motor and appliance branch circuits.
6. Flexible raceway runs.
7. Armored and metal-clad cable runs.
8. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
9. Computer and Rack-Mounted Electronic Equipment Circuits: Install insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels and power-distribution units.
10. X-Ray Equipment Circuits: Install insulated equipment grounding conductor in circuits supplying x-ray equipment.

B. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

C. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components. Ground fault protection is required on heat tracing and anti-frost heating circuits.

D. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.

E. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.

F. Signal and Communication Equipment: In addition to grounding and bonding required by NFPA 70, provide a separate grounding system complying with requirements in TIA/ATIS J-STD-607-A.

1. For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
2. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a one quarter (1/4) inch by four (4) inch by twelve (12) inch grounding bus.
3. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

G. Metal and Wood Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode, grounding electrode conductor and a separate insulated equipment grounding conductor installed with branch-circuit conductors.

## 3.4 INSTALLATION

A. Grounding Electrode and Equipment Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.

C. Ground Rods: Drive rods until tops are two (2) inches below finished floor or final grade unless otherwise indicated.

1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.

2. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.

D. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Division 26 Section "Underground Ducts and Raceways for Electrical Systems," and shall be at least twelve (12) inches deep, with cover.

1. Test Wells: Install at least one (1) test well for each service unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.

E. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

F. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

G. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install tinned bonding jumper to bond across flexible duct connections to achieve continuity.

H. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than sixty (60) feet apart.

I. Ground Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each steel column, extending around the perimeter of building.

1. Install tinned-copper conductor not less than No. 2/0 AWG for ground ring and for taps to building steel.
2. Bury ground ring not less than thirty (30) inches from building's foundation.

J. Ufer Ground (Concrete-Encased Grounding Electrode): Fabricate according to NFPA 70; use a minimum of twenty (20) feet of bare copper conductor not smaller than No. 4 AWG.

1. If concrete foundation is less than twenty (20) feet long, coil excess conductor within base of foundation.
2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building's grounding grid or to grounding electrode external to concrete.

## 3.5 LABELING

A. Comply with requirements in Division 26 Section "Identification for Electrical Systems" Article for instruction signs. The label or its text shall be green.

B. Install labels at the telecommunications bonding conductor and grounding equalizer and at the grounding electrode conductor where exposed.

1. Label Text: "If this connector or cable is loose or if it must be removed for any reason, notify the facility manager."

## 3.6 FIELD QUALITY CONTROL

A. Testing Agency: Contractor to engage a third ($3^{rd}$) Party qualified independent testing agency approved by the Maryland State Fire Marshall to perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.

3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells. Make tests at ground rods before any conductors are connected.

   a. Measure ground resistance no fewer than two (2) full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
   b. Perform tests by fall-of-potential method according to IEEE 81.

4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

C. Grounding system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

E. Report measured ground resistances that exceed the following values:

1. Power and Lighting Equipment or System with Capacity of 500 kVA and less: 10 ohms.
2. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5 ohms.
3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
4. Power Distribution Units or Panelboards Serving Electronic Equipment: 1 ohm(s).
5. Substations and Pad-Mounted Equipment: 5 ohms.
6. Manhole Grounds: 10 ohms.
7. Maximum ground-resistance value 5 ohms.

F. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify UMB promptly and include recommendations to reduce ground resistance.

END OF SECTION 260526

# SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 26.

### 1.2 SUMMARY

A. This Section includes the following:

1. Hangers and supports for electrical equipment and systems.
2. Construction requirements for concrete bases.

### 1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. IMC: Intermediate metal conduit.

C. RMC: Rigid metal conduit.

### 1.4 PERFORMANCE REQUIREMENTS

A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

C. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

### 1.5 SUBMITTALS

A. Product Data: For the following:

1. Steel slotted support systems.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:

1. Trapeze hangers. Include Product Data for components.
2. Steel slotted channel systems. Include Product Data for components.
3. Equipment supports.

C. Welding certificates.

1.6 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Comply with NFPA 70.

1.7 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

1.8 WARRANTY/GUARANTEE

A. See Division 26 Specification Section “Basic Electrical Requirements’ for warranty and guarantee requirements.

**PART 2 - PRODUCTS**

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Allied Tube & Conduit.
b. Cooper B-Line, Inc.; a division of Cooper Industries.

c. ERICO International Corporation.
d. GS Metals Corp.
e. Thomas & Betts Corporation.
f. Unistrut; Tyco International, Ltd.
g. Wesanco, Inc.

2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
3. Channel Dimensions: Selected for applicable load criteria.

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

C. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) Hilti Inc.
2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
3) MKT Fastening, LLC.
4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.

2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) Cooper B-Line, Inc.; a division of Cooper Industries.

2) Empire Tool and Manufacturing Co., Inc.
3) Hilti Inc.
4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
5) MKT Fastening, LLC.

3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
6. Toggle Bolts: All-steel springhead type.
7. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.

**PART 3 - EXECUTION**

3.1 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with single-bolt conduit clamps using spring friction action for retention in support channel.

## 3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
2. To New Concrete: Bolt to concrete inserts.
3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. To Existing Concrete: Expansion anchor fasteners.
5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
6. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
7. To Light Steel: Sheet metal screws.
8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate

D. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

## 3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

## 3.4 CONCRETE BASES

A. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 Section "Cast-in-Place Concrete."

C. Anchor equipment to concrete base.

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

## 3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 260529

# SECTION 260533 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 26.

SUMMARY

B. Related Sections include the following:

1. Division 26 Section "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.

### 1.2 DEFINITIONS

A. RMC: Rigid metallic conduit.

B. PVC/RMC: PVC coated rigid metallic conduit.

C. EMT: Electrical metallic tubing.

D. EPDM: Ethylene-propylene-diene terpolymer rubber.

E. FMC: Flexible metal conduit.

F. LFMC: Liquidtight flexible metal conduit.

G.

H. NBR: Acrylonitrile-butadiene rubber.

I. RNC: Rigid nonmetallic conduit.

### 1.3 SUBMITTALS

A. Product Data: For raceways, wire ways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. Shop Drawings: For the following raceway components. Include plans, elevations, sections, details, and attachments to other work.

1. Custom enclosures and cabinets include layout drawings showing components and wiring.

C. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Structural members in the paths of conduit groups with common supports.
2. HVAC and plumbing items and architectural features in the paths of conduit groups with common supports.

D. Source quality-control test reports.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

C. Coordinate layout and installation of raceways and boxes with other construction elements to ensure adequate headroom, working clearance, and access and eliminate interference problems.

1.5 WARRANTY/GUARANTEE

A. See Division 26 Specification Section “Basic Electrical Requirements’ for warranty and guarantee requirements.

**PART 2 - PRODUCTS**

2.1 METAL CONDUIT AND TUBING

A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. AFC Cable Systems, Inc.
2. Alflex Inc.

3. Allied Tube & Conduit; a Tyco International Ltd. Co.
4. Anamet Electrical, Inc.; Anaconda Metal Hose.
5. Electri-Flex Co.
6. O-Z Gedney; a unit of General Signal.
7. Wheatland Tube Company.

B. Rigid Steel Conduit: ANSI C80.1.

C. EMT: ANSI C80.3.

D. FMC: Zinc-coated steel.

E. LFMC: Flexible steel conduit with PVC jacket.

F. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.

1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.
2. Fittings for EMT: Steel [compression] type.
3. Coating for Fittings for PVC-Coated Conduit: Minimum thickness, 0.040 inch, with overlapping sleeves protecting threaded joints.

G. Joint Compound for Rigid Steel Conduit or IMC: Listed for use in cable connector assemblies, and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

## 2.2 NONMETALLIC CONDUIT AND TUBING

A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. AFC Cable Systems, Inc.
2. Arnco Corporation.
3. CertainTeed Corp.; Pipe & Plastics Group.
4. Lamson & Sessions; Carlon Electrical Products.
5. Manhattan/CDT/Cole-Flex.
6. RACO; a Hubbell Company.
7. Thomas & Betts Corporation.

B. RNC: NEMA TC 2, Type EPC-40-PVC, unless otherwise indicated.

C. Fittings for RNC: NEMA TC 3; match to conduit or tubing type and material.

## 2.3 OPTICAL FIBER/COMMUNICATIONS CABLE RACEWAY AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Arnco Corporation.
2. Endot Industries Inc.
3. IPEX Inc.
4. Lamson & Sessions; Carlon Electrical Products.

B. Description: Comply with UL 2024; flexible type, approved for plenum [riser] general-use installation.

## 2.4 METAL WIREWAYS

A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. Cooper B-Line, Inc.
2. Hoffman.
3. Square D; Schneider Electric.

B. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type 1, unless otherwise indicated.

C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireway Covers: Hinged type. Secured with stainless steel screws.

E. Finish: Manufacturer's standard enamel finish.

## 2.5 BOXES, ENCLOSURES, AND CABINETS

A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
2. EGS/Appleton Electric.
3. Hoffman.
4. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
5. O-Z/Gedney; a unit of General Signal.
6. Robroy Industries, Inc.; Enclosure Division.
7. Scott Fetzer Co.; Adalet Division.

8. Spring City Electrical Manufacturing Company.
9. Thomas & Betts Corporation.
10. Walker Systems, Inc.; Wiremold Company (The).

B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.

C. Nonmetallic Outlet and Device Boxes: NEMA OS 2.

D. Exterior and Wet locations
1. Cast aluminum or galvanized cast iron type.
2. Threaded hubs.
3. Gasket screw-on cover plates
4. NEMA FB-1

E. Boxes embedded in concrete
1. NEMA 4X PVC
a. Glue-in conduit hubs
b. Gasket cover plates
c. Sunlight UV resistant

F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

G. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Nonmetallic Enclosures: Plastic finished inside with radio-frequency-resistant paint.

H. Cabinets:

1. NEMA 250, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.

## 2.6 SLEEVES FOR RACEWAYS

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

C. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.052- or 0.138-inch thickness as indicated and of length to suit application.

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

2.7 SLEEVE SEALS

A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. Advance Products & Systems, Inc.
2. Calpico, Inc.
3. Metraflex Co.
4. Pipeline Seal and Insulator, Inc.

B. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.

1. Sealing Elements: NBR interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
2. Pressure Plates: Stainless steel. Include two for each sealing element.
3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

**PART 3 - EXECUTION**

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:

1. Exposed Conduit: RMC.
2. Concealed Conduit, Aboveground: RNC, Type EPC-40-PVC.
3. Underground Conduit: RNC, Type EPC-40-PVC, direct buried.
4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R or 4.

B. Comply with the following indoor applications, unless otherwise indicated:

1. Exposed, Office Spaces: EMT.
2. Conduits > 2”: Rigid Steel.
3. All wiring > than 600 volts: Rigid Steel.

4. Exposed and Subject to Severe Physical Damage: Rigid steel conduit. Includes raceways in the following locations:

   a. Loading dock.
   b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
   c. Mechanical and Electrical rooms and IT Rooms/Closets.

5. Concealed in Ceilings and Interior Walls and Partitions: EMT.
6. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
7. Damp or Wet Locations: Rigid steel conduit.
8. Raceways for Optical Fiber or Communications Cable in Spaces Used for Environmental Air: EMT.
9. Raceways for Optical Fiber or Communications Cable Risers in Vertical Shafts: EMT.
10. Raceways for Concealed General Purpose Distribution of Optical Fiber or Communications Cable: EMT.
11. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, stainless steel in damp or wet locations.

C. Minimum Raceway Size: Three quarter (3/4) inch trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.

## 3.2 INSTALLATION

A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.

B. Keep raceways at least six (6) inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

C. Complete raceway installation before starting conductor installation.

D. Support raceways as specified in Division 26 Section "Hangers and Supports for Electrical Systems."

E. Arrange stub-ups so curved portions of bends are not visible above the finished slab.

F. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.

G. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.

H. Raceways Embedded in Slabs:

1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
3. Change from RNC to rigid steel conduit before rising above the floor.

I. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

J. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.

K. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least twelve (12) inches of slack at each end of pull wire.

L. Raceways for Optical Fiber and Communications Cable: Install raceways, metallic and nonmetallic, rigid and flexible, as follows:

1. Three quarter (3/4) Inch Trade Size and Smaller: Install raceways in maximum lengths of fifty (50) feet.
2. One (1) Inch Trade Size and Larger: Install raceways in maximum lengths of seventy five (75) feet.
3. Install with a maximum of two 90-degree bends or equivalent for each length of raceway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.

M. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where otherwise required by NFPA 70.

N. Expansion-Joint Fittings for RNC: Install in each run of aboveground conduit that is located where environmental temperature change may exceed $30^0$F, and that has straight-run length that exceeds 25 feet.

1. Install expansion-joint fittings for each of the following locations, and provide type and quantity of fittings that accommodate temperature change listed for location:

   a. Outdoor Locations Not Exposed to Direct Sunlight: $125^0$F temperature change.
   b. Outdoor Locations Exposed to Direct Sunlight: $155^0$F temperature change.
   c. Indoor Spaces: Connected with the Outdoors without Physical Separation: $125^0$F temperature change.
   d. Attics: $135^0$F temperature change.

2. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per $^0$F of temperature change.
3. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at the time of installation.

O. Flexible Conduit Connections: Use maximum of seventy two (72) inches of flexible conduit for recessed and semirecessed lighting fixtures, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

1. Use LFMC in damp or wet locations subject to severe physical damage.
2. Use LFMC in damp or wet locations not subject to severe physical damage.

P. Set metal floor boxes level and flush with finished floor surface.

Q. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

## 3.3 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Rectangular Sleeve Minimum Metal Thickness:

1. For sleeve cross-section rectangle perimeter less than fifty (50) inches and no side greater than 16 inches, thickness shall be 0.052 inch.
2. For sleeve cross-section rectangle perimeter equal to, or greater than, fifty (50) inches and one (1) or more sides equal to, or greater than, sixteen (16) inches, thickness shall be 0.138 inch.

E. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

F. Cut sleeves to length for mounting flush with both surfaces of walls.

G. Extend sleeves installed in floors two (2) inches above finished floor level.

H. Size pipe sleeves to provide one quarter (1/4) inch annular clear space between sleeve and raceway unless sleeve seal is to be installed or unless seismic criteria require different clearance.

I. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.

J. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway, using joint sealant appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.

K. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway penetrations. Install sleeves and seal with firestop materials. Comply with Division 07 Section "Penetration Firestopping."

L. Roof-Penetration Sleeves: Seal penetration of individual raceways with flexible, boot-type flashing units applied in coordination with roofing work.

M. Aboveground, Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

## 3.4 SLEEVE-SEAL INSTALLATION

A. Use type and number of sealing elements recommended by manufacturer for raceway material and size. Position raceway in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

## 3.5 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

## 3.6 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 260533

# SECTION 260536 - CABLE TRAYS FOR ELECTRICAL SYSTEMS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 26.

### 1.2 SUMMARY

A. This Section includes aluminum cable trays and accessories.

### 1.3 SUBMITTALS

A. Product Data: Include data indicating dimensions and finishes for each type of cable tray indicated.

B. Shop Drawings: For each type of cable tray.

1. Show fabrication and installation details of cable tray, including plans, elevations, and sections of components and attachments to other construction elements. Designate components and accessories, including clamps, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies, straight lengths, and fittings.

C. Coordination Drawings: Floor plans and sections, drawn to scale. Include scaled cable tray layout and relationships between components and adjacent structural, electrical, and mechanical elements. Show the following:

1. Vertical and horizontal offsets and transitions.
2. Clearances for access above and to side of cable trays.
3. Vertical elevation of cable trays above the floor or bottom of ceiling structure.

D. Field quality-control reports.

E. Operation and Maintenance Data: For cable trays to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain cable tray components through one source from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store indoors to prevent water or other foreign materials from staining or adhering to cable tray. Unpack and dry wet materials before storage.

1.6 WARRANTY/GUARANTEE

A. See Division 26 Specification Section “Basic Electrical Requirements’ for warranty and guarantee requirements.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. Cooper B-Line, Inc.
2. Cope, T. J., Inc.; a subsidiary of Allied Tube & Conduit.
3. GS Metals Corp.; GLOBETRAY Products.
4. MONO-SYSTEMS, Inc.
5. MPHusky.
6. PW Industries.

2.2 MATERIALS AND FINISHES

A. Cable Trays, Fittings, and Accessories: Steel, complying with NEMA VE 1.

1. Hot-dip galvanized after fabrication, complying with ASTM A 123/A 123M, Class B2; with chromium-zinc, ASTM F 1136, hardware.

B. Sizes and Configurations:

1. Ladder Type (Vertical Risers Only): Ladder type transverse rungs welded to side rails shall be 9 inches on center. Rungs shall have a minimum bearing surface of 3/4 inch radius edges.

2. Ventilated Trough Type: Corrugated trough bottoms shall be welded to the side rails and have a minimum cable bearing surface of 2-3/4 inches on [6[ [9] inch centers. Ventilation holes (2-1/4 inch x 4 inch) shall be punched along the width of the valleys.

3. Dimensions:

   a. Tray width shall be as shown on drawings.
   b. Side rails height inches/cable fill depth shall be [6/5inches.

## 2.3 CABLE TRAY ACCESSORIES

A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.

   1. Horizontal and vertical pivot splice blocks, connectors, as required.

   2. Manufacturer's stiffener bars installed on all eighteen (18) inch wide sections to stabilize tray when loaded unevenly.

B. Barrier Strips: Same materials and finishes as cable tray.

C. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

## 2.4 WARNING SIGNS

A. Lettering: 1-1/2-inch- high, black letters on yellow background with legend "WARNING! NOT TO BE USED AS WALKWAY, LADDER, OR SUPPORT FOR LADDERS OR PERSONNEL."

B. Materials and fastening are specified in Division 26 Section "Identification for Electrical Systems."

## 2.5 SOURCE QUALITY CONTROL

A. Perform design and production tests according to NEMA FG 1 NEMA VE 1.

## PART 3 - EXECUTION

### 3.1 CABLE TRAY INSTALLATION

A. Comply with recommendations in NEMA VE 2. Install as a complete system, including all necessary fasteners, hold-down clips, splice-plate support systems, barrier strips, hinged horizontal and vertical splice plates, elbows, reducers, tees, and crosses.

B. Remove burrs and sharp edges from cable trays.

C. Fasten cable tray supports to building structure.

1. Place supports so that spans do not exceed manufacturer's maximum spans.
2. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.
3. Support bus assembly to prevent twisting from eccentric loading.
4. Manufacture center-hung support, designed for 60% versus 40% eccentric loading condition, with a safety factor of three (3).
5. Locate, design and install supports according to NEMA FG 1 NEMA VE 1, or the calculated load multiplied by a safety factor of four (4), or the calculated load plus two hundred (200) lbs (90 kg) whichever is the greater.

D. Retain paragraph below if cable tray connects to equipment. Make connections to equipment with flanged fittings fastened to cable tray and to equipment. Support cable tray independent of fittings. Do not carry weight of cable tray on equipment enclosure.

E. Retain first paragraph below if expansion fittings are required. Install expansion connectors where cable tray crosses building expansion joint and in cable tray runs that exceed dimensions recommended in NEMA FG 1 NEMA VE 1. Space connectors and set gaps according to applicable standard.

F. Make changes in direction and elevation using standard fittings.

G. Make cable tray connections using standard fittings.

H. Seal penetrations through fire and smoke barriers according to Division 07 Section "Penetration Firestopping."

I. Sleeves for Future Cables: Install capped sleeves for (25% growth) future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.

J. Workspace: Install cable trays with minimum eighteen (18) inches above tray to permit access for installing cables.

K. Install barriers to separate cables of different systems, such as power, communications, and data processing. Mixing 600, 5,000 and 15,000 systems in the same cable tray is not permitted.

L. After installation of cable trays is completed, install warning signs in visible locations on or near cable trays.

## 3.2 CABLE INSTALLATION

A. Install cables only when cable tray installation has been completed and inspected.

B. Fasten cables on horizontal runs with cable clamps or cable ties as recommended by NEMA VE 2. Tighten clamps only enough to secure the cable, without indenting the cable jacket. Install cable ties with a tool that includes an automatic pressure-limiting device.

C. On vertical runs, fasten cables to tray every eighteen (18) inches. Install intermediate supports when cable weight exceeds the load-carrying capacity of the tray rungs.

D. In existing construction, remove inactive or dead cables from cable tray.

E. Install covers after installation of cable is completed. Delete this

## 3.3 CONNECTIONS

A. Ground cable trays according to manufacturer's written instructions.

B. Install an insulated equipment grounding conductor with cable tray, in addition to those required by NFPA 70.

C. Install insulated bonding jumper cable, sized per NEC, between bolted connections.

## 3.4 FIELD QUALITY CONTROL

A. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements. Perform the following field quality-control survey:

1. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable tray, vibration, and thermal expansion and contraction conditions, which may cause or have caused damage.
2. Verify that the number, size, and voltage of cables in cable tray do not exceed that permitted by NFPA 70. Verify that communication or data-processing circuits are separated from power circuits by barriers.

3. Verify that there is no intrusion of such items as pipe, hangers, or other equipment that could damage cables.
4. Remove deposits of dust, industrial process materials, trash of any description, and any blockage of tray ventilation.
5. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorque in suspect areas.
6. Check for missing or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
7. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable tray.

B. Report results in writing.

## 3.5 PROTECTION

A. Protect installed cable trays.

1. Repair damage finishes with methods and products as recommended by cable tray manufacturer.
2. Install temporary protection for cables in open trays to protect exposed cables from falling objects or debris during construction. Temporary protection for cables and cable tray can be constructed of wood or metal materials until the risk of damage is over.

END OF SECTION 260536

# SECTION 260543 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

B. All work performed on Baltimore City Property or Right-of-Ways shall conform to standards of the Baltimore City Department of Public Works.

### 1.2 SUMMARY

A. This Section includes the following:

1. Conduit, ducts, and duct accessories for direct-buried and concrete-encased duct banks.
2. Handholes and boxes.
3. Manholes.

### 1.3 DEFINITION

A. RNC: Rigid nonmetallic conduit.

### 1.4 ACTION SUBMITTALS

A. Product Data: For the following:

1. Duct-bank materials, including separators and miscellaneous components.
2. Ducts and conduits and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
3. Accessories for manholes, handholes, boxes, and other utility structures.
4. Warning tape.
5. Warning planks.

B. Shop Drawings for Precast or Factory-Fabricated Underground Utility Structures: Include plans, elevations, sections, details, attachments to other work, and accessories, including the following:

1. Duct entry provisions, including locations and duct sizes.

2. Reinforcement details.
3. Frame and cover design and manhole frame support rings.
4. Grounding details.
5. Dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.
6. Joint details.
7. Submit shop drawings and sketches of proposed manhole design.

C. Shop Drawings for Factory-Fabricated Handholes and Boxes Other Than Precast Concrete: Include dimensioned plans, sections, and elevations, and fabrication and installation details, including the following:

1. Duct entry provisions, including locations and duct sizes.
2. Cover design (including cover legend).
3. Grounding details.
4. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.

## 1.5 INFORMATIONAL SUBMITTALS

A. Duct-Bank Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures.

1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.
2. Drawings shall be signed and sealed by a qualified professional engineer.
3. Maintain copy in field for red-line drawings and as-built purposes.

B. Product Certificates: For concrete and steel used in precast concrete manholes and handholes, as required by ASTM C 858.

C. Qualification Data: For professional engineer and testing agency.

D. Source quality-control test reports.

E. Field quality-control test reports.

## 1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

B. Comply with ANSI C2.

C. Comply with NFPA 70.

## 1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver ducts to Project site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.

B. Store precast concrete and other factory-fabricated underground utility structures at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.

C. Lift and support precast concrete units only at designated lifting or supporting points.

## 1.8 PROJECT CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by UM or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify UM, in writing, no fewer than 10 days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without UMB's written permission.

## 1.9 COORDINATION

A. Coordinate layout and installation of ducts, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field.

B. Coordinate elevations of ducts and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of ducts and duct banks as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations from those indicated as required to suit field conditions and to ensure that duct runs drain to manholes and handholes, and as approved by Architect.

## 1.10 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

B. Furnish cable-support stanchions, arms, insulators, and associated fasteners in quantities equal to 5 percent of quantity of each item installed.

## PART 2 - PRODUCTS

### 2.1 CONDUIT

A. Rigid Steel Conduit: PVC-Coated Steel. Comply with NEMA RN 1.

1. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.

B. RNC: NEMA TC 2, Type EPC-40-PVCUL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

### 2.2 NONMETALLIC DUCTS AND DUCT ACCESSORIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ARNCO Corp.
2. Beck Manufacturing.
3. Cantex, Inc.
4. CertainTeed Corp.; Pipe & Plastics Group.
5. Condux International, Inc.
6. ElecSys, Inc.
7. Electri-Flex Company.
8. IPEX Inc.
9. Lamson & Sessions; Carlon Electrical Products.
10. Manhattan/CDT; a division of Cable Design Technologies.
11. Spiraduct/AFC Cable Systems, Inc.

B. Duct Accessories:

1. Duct Separators: Factory-fabricated rigid PVC interlocking spacers, sized for type and sizes of ducts with which used, and selected to provide minimum duct spacings indicated while supporting ducts during concreting or backfilling.
2. Warning Tape: Underground-line warning tape specified in Division 26 Section "Identification for Electrical Systems."
3. Concrete Warning Planks: Nominal 12 by 24 by 3 inches in size, manufactured from 6000-psi concrete.

    a. Color: Red dye added to concrete during batching.
    b. Mark each plank with "ELECTRIC" in 2-inch- high, 3/8-inch- deep letters.

## 2.3 PRECAST CONCRETE HANDHOLES AND BOXES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Carder Concrete Products.
2. Christy Concrete Products.
3. Elmhurst-Chicago Stone Co.
4. Oldcastle Precast Group.
5. Riverton Concrete Products; a division of Cretex Companies, Inc.
6. Utility Concrete Products, LLC.
7. Utility Vault Co.
8. Wausau Tile, Inc.

B. Comply with ASTM C 858 for design and manufacturing processes.

C. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or box.

1. Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
2. Frame and Cover: Weatherproof steel frame, with steel cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
3. Frame and Cover: Weatherproof steel frame, with hinged steel access door assembly with tamper-resistant, captive, cover-securing bolts.

    a. Cover Hinges: Concealed, with hold-open ratchet assembly.
    b. Cover Handle: Recessed.

4. Frame and Cover: Weatherproof aluminum frame with hinged aluminum access door assembly with tamper-resistant, captive, cover-securing bolts.

    a. Cover Hinges: Concealed, with hold-open ratchet assembly.
    b. Cover Handle: Recessed.

5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
6. Cover Legend: Molded lettering, "UMB ELECTRIC." or "UMB COMMUNICATIONS" or "UMB SPECIAL SYSTEMS." As indicated for each service.
7. Configuration: Units shall be designed for flush burial and have integral closed bottom, unless otherwise indicated.
8. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.

a. Extension shall provide increased depth of 12 inches.
b. Slab: Same dimensions as bottom of enclosure, and arranged to provide closure.

9. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches vertically and horizontally to accommodate alignment variations.

a. Windows shall be located no less than 6 inches from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.
b. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
c. Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.

10. Duct Entrances in Handhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.

a. Type and size shall match fittings to duct or conduit to be terminated.
b. Fittings shall align with elevations of approaching ducts and be located near interior corners of handholes to facilitate racking of cable.

11. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

## 2.4 HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. Description: Comply with SCTE 77.

1. Color: “GRAY”
2. Configuration: Units shall be designed for flush burial and have integral closed bottom, unless otherwise indicated.
3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
5. Cover Legend: Molded lettering, "UM ELECTRIC." "UM COMMUNICATIONS” or “UM SPECIAL SYSTEMS." As indicated for each service.
6. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.

7. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
8. Handholes 12 inches wide by 24 inches long and larger shall have factory-installed inserts for cable racks and pulling-in irons.

B. Polymer Concrete Handholes and Boxes with Polymer Concrete Cover: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Armorcast Products Company.
    b. Carson Industries LLC.
    c. CDR Systems Corporation.
    d. NewBasis.

C. Fiberglass Handholes and Boxes with Polymer Concrete Frame and Cover: Sheet-molded, fiberglass-reinforced, polyester resin enclosure joined to polymer concrete top ring or frame.

    a. Manufacturers: Subject to compliance with requirements, provide products by one of the Armorcast Products Company.
    b. Carson Industries LLC.
    c. Christy Concrete Products.
    d. Synertech Moulded Products, Inc.; a division of Oldcastle Precast.

D. Fiberglass Handholes and Boxes: Molded of fiberglass-reinforced polyester resin, with covers of hot-dip galvanized-steel diamond plate.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Carson Industries LLC.
    b. Christy Concrete Products.
    c. Nordic Fiberglass, Inc.

E. High-Density Plastic Boxes: Injection molded of high-density polyethylene or copolymer-polypropylene. Cover shall be hot-dip galvanized-steel diamond plate.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Carson Industries LLC.
    b. Nordic Fiberglass, Inc.
    c. PenCell Plastics.

2.5 PRECAST MANHOLES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Carder Concrete Products.
2. Christy Concrete Products.
3. Elmhurst-Chicago Stone Co.
4. Oldcastle Precast Group.
5. Riverton Concrete Products; a division of Cretex Companies, Inc.
6. Utility Concrete Products, LLC.
7. Utility Vault Co.
8. Wausau Tile, Inc.
9. Gannett Fleming, Inc.
10. Approved Equal.

B. Comply with ASTM C 858, with structural design loading as specified in Part 3 "Underground Enclosure Application" Article and with interlocking mating sections, complete with accessories, hardware, and features.

1. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches vertically and horizontally to accommodate alignment variations.

a. Windows shall be located no less than 6 inches from interior surfaces of walls, floors, or roofs of manholes, but close enough to corners to facilitate racking of cables on walls.
b. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
c. Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.

2. Duct Entrances in Manhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.

a. Type and size shall match fittings to duct or conduit to be terminated.
b. Fittings shall align with elevations of approaching ducts and be located near interior corners of manholes to facilitate racking of cable.

C. Concrete Knockout Panels: 1-1/2 to 2 inches thick, for future conduit entrance and sleeve for ground rod.

D. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

## 2.6 CAST-IN-PLACE MANHOLES

A. Description: Underground utility structures, constructed in place, complete with accessories, hardware, and features. Include concrete knockout panels for conduit entrance and sleeve for ground rod. Provide adequate sleeves for 4 sets of 12-way, 5" ducts with minimum 6" between ducts. Sleeves shall be 7.5" minimum outside diameter (OD). Include 2 pulling irons per manhole face and floor.

B. Materials: Comply with ASTM C 858 and with Division 03 Section "Cast-in-Place Concrete."

C. Structural Design Loading: As specified in Part 3 "Underground Enclosure Application" Article.

## 2.7 UTILITY STRUCTURE ACCESSORIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Bilco Company (The).
2. Campbell Foundry Company.
3. Carder Concrete Products.
4. Christy Concrete Products.
5. East Jordan Iron Works, Inc.
6. Elmhurst-Chicago Stone Co.
7. McKinley Iron Works, Inc.
8. Neenah Foundry Company.
9. New Basis.
10. Oldcastle Precast Group.
11. Osburn Associates, Inc.
12. Pennsylvania Insert Corporation.
13. Riverton Concrete Products; a division of Cretex Companies, Inc..
14. Strongwell Corporation; Lenoir City Division.
15. Underground Devices, Inc.
16. Utility Concrete Products, LLC.
17. Utility Vault Co.
18. Wausau Tile, Inc.

B. Manhole Frames, Covers, and Chimney Components: Comply with structural design loading specified for manhole.

1. Frame and Cover: Weatherproof, gray cast iron complying with ASTM A 48/A 48M, Class 30B with milled cover-to-frame bearing surfaces; diameter, 26 inches.

a. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
b. Special Covers: Recess in face of cover designed to accept finish material in paved areas.

2. Cover Legend: Cast in. Selected to suit system.

a. Legend: "UM ELECTRIC-LV" for duct systems with power wires and cables for systems operating at 600 V and less.
b. Legend: "UM ELECTRIC-HV" for duct systems with medium-voltage cables.
c. Legend: "UM COMMUNICATIONS" or "UM SPECIAL SYSTEMS" for communications, data, and telephone duct systems.

3. Manhole Chimney Components: Precast concrete rings with dimensions matched to those of roof opening.

a. Mortar for Chimney Ring and Frame and Cover Joints: Comply with ASTM C 270, Type M, except for quantities less than 2.0 cu. ft. where packaged mix complying with ASTM C 387, Type M, may be used.

C. Manhole Sump Frame and Grate: ASTM A 48/A 48M, Class 30B, gray cast iron.

D. Pulling Eyes in Concrete Walls: Eyebolt with reinforcing-bar fastening insert, 2-inch-diameter eye, and 1-by-4-inch bolt. Provide two per face.

1. Working Load Embedded in 6-Inch, 4500-psi Concrete: 13,000-lbf minimum tension.

E. Pulling-In and Lifting Irons in Concrete Floors: 7/8-inch- diameter, hot-dip galvanized, bent steel rod; stress relieved after forming; and fastened to reinforcing rod. Exposed triangular opening. Provide two per floor.

1. Ultimate Yield Strength: 40,000-lbf shear and 60,000-lbf tension.

F. Bolting Inserts for Concrete Utility Structure Cable Racks and Other Attachments: Flared, threaded inserts of noncorrosive, chemical-resistant, nonconductive thermoplastic material; 1/2-inch ID by 2-3/4 inches deep, flared to 1-1/4 inches minimum at base.

1. Tested Ultimate Pullout Strength: 12,000 lbf minimum.

G. Expansion Anchors for Installation after Concrete Is Cast: Zinc-plated, carbon-steel-wedge type with stainless-steel expander clip with 1/2-inch bolt, 5300-lbf rated pullout strength, and minimum 6800-lbf rated shear strength.

H. Cable Rack Assembly: Nonmetallic. Components fabricated from nonconductive, fiberglass-reinforced polymer.

1. Stanchions: Nominal 36 inches high by 4 inches wide, with minimum of 9 holes for arm attachment. Provide minimum two (2) stanchions per manhole wall. Maintain 18" from corner of wall. Provide additional stanchions if spacing exceeds 30".
2. Arms: Arranged for secure, drop-in attachment in horizontal position at any location on cable stanchions, and capable of being locked in position. Arms shall be minimum 8" long with 3 arms per stanchion, with 450-lb minimum capacity to 20 inches with 250-lb minimum capacity. Top of arm shall be nominally 4 inches wide, and arm shall have slots along full length for cable ties.

I. Duct-Sealing Compound: Non-hardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as $35^0$F. Capable of withstanding temperature of $300^0$F without slump and adhering to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.

J. Fixed Manhole Ladders: Arranged for attachment to roof, wall, and floor of manhole. Ladder and mounting brackets and braces shall be fabricated from nonconductive, structural-grade, fiberglass-reinforced resin

K. Portable Manhole Ladders: UL-listed, heavy-duty fiberglass specifically designed for portable use for access to electrical manholes. Minimum length equal to distance from deepest manhole floor to grade plus 36 inches. Onerequired.

L. Cover Hooks: Heavy duty, designed for lifts 60 lbf and greater]. Two required.

M. Duct Identification System: Provide duct tag or sleeve system for numbering individual ducts in accordance with Specification 260533 "Identification for Electrical Systems."

## 2.8 SOURCE QUALITY CONTROL

A. Test and inspect precast concrete utility structures according to ASTM C 1037.

B. Non-concrete Handhole and Pull-Box Prototype Test: Test prototypes of manholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

1. Strength tests of complete boxes and covers shall be by either an independent testing agency or the manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
2. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

## PART 3 - EXECUTION

### 3.1 UNDERGROUND DUCT APPLICATION

A. Ducts for Electrical Cables Over 600 V: RNC, NEMA Type EPC-40-PVC, in concrete-encased steel-rebar reinforced duct bank, unless otherwise indicated.

B. Ducts for Electrical Feeders 600 V and Less: RNC, NEMA Type EPC-40-PVC, in concrete-encased duct bank, unless otherwise indicated.

C. Ducts for Electrical Branch Circuits: RNC, NEMA Type EPC-80-PVC, in direct-buried duct bank, unless otherwise indicated.

D. Underground Ducts for Telephone, Communications, or Data Utility Service Cables: RNC, NEMA Type EPC-40-PVC, in concrete-encased duct bank, unless otherwise indicated.

E. Underground Ducts for Telephone, Communications, or Data Utility Service Cables: RNC, NEMA Type EPC-40-PVC, installed in [direct-buried] [concrete-encased] duct bank, unless otherwise indicated.

F. Underground Ducts Crossing Paved Paths, Walks, Driveways, Roadways, and Railroads: RNC, NEMA Type EPC-40-PVC, encased in reinforced concrete.

### 3.2 UNDERGROUND ENCLOSURE APPLICATION

A. Handholes and Boxes for 600 V and Less, Including Telephone, Communications, and Data Wiring:

1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete. AASHTO HB 17, H-20 structural load rating.
2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Precast concrete, AASHTO HB 17, H-20.
3. Units Subject to Light-Duty Pedestrian Traffic Only: [Fiberglass-reinforced polyester resin] [High-density plastic], structurally tested according to SCTE 77 with 3000-lbf vertical loading.

B. Manholes: Precast or cast-in-place concrete.

1. Units Located in Roadways and Other Deliberate Traffic Paths by Heavy or Medium Vehicles: H-20 structural load rating according to AASHTO HB 17.
2. Units Not Located in Deliberate Traffic Paths by Heavy or Medium Vehicles: H-10 load rating according to AASHTO HB 17.

## 3.3 EARTHWORK

A. Excavation and Backfill: Comply with Division 31 Section "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.

B. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Division 32 Sections "Turf and Grasses" and "Plants."

C. Cut and patch existing pavement in the path of underground ducts and utility structures according to Division 01 Section "Cutting and Patching."

## 3.4 DUCT INSTALLATION

A. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes to drain in both directions.

B. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use 5" 60-degree manufactured long sweep bends with a minimum radius of 25 feet, both horizontally and vertically, at other locations, unless otherwise indicated.

C. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.

D. Duct Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches o.c. for 5-inch ducts, and vary proportionately for other duct sizes.

1. Begin change from regular spacing to end-bell spacing 10 feet from the end bell without reducing duct line slope and without forming a trap in the line.
2. Direct-Buried Duct Banks: Install an expansion and deflection fitting in each conduit in the area of disturbed earth adjacent to manhole or handhole.
3. Grout end bells into structure walls from both sides to provide watertight entrances.

E. Building Wall Penetrations: Make a transition from underground duct to rigid steel conduit at the building wall via metal junction box inside building. Use fittings manufactured for duct-to-conduit transition. Install conduit penetrations of building walls as specified in Division 26 Section "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

F. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.

G. Pulling Cord: Install 100-lbf- test nylon cord in ducts, including spares.

H. Concrete-Encased Ducts: Support ducts on duct separators.

1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, with not less than [4] [5] spacers per 20 feet of duct. Secure separators to earth and to ducts to prevent floating during concreting. Stagger separators approximately 6 inches between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
2. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.

    a. Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written recommendations, or use other specific measures to prevent expansion-contraction damage.
    b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch reinforcing rod dowels extending 18 inches into concrete on both sides of joint near corners of envelope.

3. Pouring Concrete: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.
4. Reinforcement: Provide rebar reinforcement as directed on Drawings. Reinforce concrete-encased duct banks where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
5. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
6. Minimum Space between Ducts: 3 inches between ducts and exterior envelope wall, 2 inches between ducts for like services, and 4 inches between power and signal ducts.
7. Depth: Install bottom of duct bank at 60 inches (1525 mm) below grade and top of duct bank at least 24 inches below finished grade in areas not subject to deliberate traffic, and at least 30 inches below finished grade in deliberate traffic paths for vehicles, unless otherwise indicated.

8. Stub-Ups: Use manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.

    a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
    b. Stub-Ups to Equipment: For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of base. Install insulated grounding bushings on terminations at equipment.

9. Warning Tape: Bury warning tape approximately 12 inches above all concrete-encased ducts and duct banks. Align tape parallel to and within 3 inches of the centerline of duct bank. Provide an additional warning tape for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional tapes 12 inches apart, horizontally.

I. Direct-Buried Duct Banks:

1. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.
2. Space separators close enough to prevent sagging and deforming of ducts, with not less than 5 spacers per 20 feet of duct. Secure separators to earth and to ducts to prevent displacement during backfill and yet permit linear duct movement due to expansion and contraction as temperature changes. Stagger spacers approximately 6 inches between tiers.
3. Excavate trench bottom to provide firm and uniform support for duct bank. Prepare trench bottoms as specified in Division 31 Section "Earth Moving" for pipes less than 6 inches in nominal diameter.
4. Install backfill as specified in Division 31 Section "Earth Moving."
5. After installing first tier of ducts, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand-place backfill to 4 inches over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction as specified in Division 31 Section "Earth Moving."
6. Install ducts with a minimum of 3 inches between ducts for like services and 6 inches between power and signal ducts.
7. Depth: Install top of duct bank at least 36 inches below finished grade, unless otherwise indicated.
8. Set elevation of bottom of duct bank below the frost line.
9. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.

a. Couple PVC-coated steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
b. For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.

10. Warning Planks: Bury warning planks approximately 12 inches above direct-buried ducts and duct banks, placing them 24 inches o.c. Align planks along the width and along the centerline of duct bank. Provide an additional plank for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional planks 12 inches apart, horizontally.

## 3.5 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

A. Cast-in-Place Manhole Installation:

1. Finish interior surfaces with a smooth-troweled finish.
2. Windows for Future Duct Connections: Form and pour concrete knockout panels 1-1/2 to 2 inches thick, arranged as indicated.
3. Cast-in-place concrete, formwork, and reinforcement are specified in Division 03 Section "Cast-in-Place Concrete."

B. Precast Concrete Handhole and Manhole Installation:

1. Comply with ASTM C 891, unless otherwise indicated.
2. Install units level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.
3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevations:

1. Manhole Roof: Install with rooftop at least 15 inches below finished grade.
2. Manhole Frame: In paved areas and traffic ways, set frames flush with finished grade. Set other manhole frames 1 inch above finished grade.
3. Install handholes with bottom below the frost line.
4. Handhole Covers: In paved areas and traffic ways, set surface flush with finished grade. Set covers of other handholes 1 inch above finished grade.
5. Where indicated, cast handhole cover frame integrally with handhole structure.

D. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.

E. Manhole Access: Circular opening in manhole roof; sized to match cover size.

1. Install chimney, constructed of precast concrete collars and rings to support frame and cover and to connect cover with manhole roof opening. Provide moisture-tight masonry joints and waterproof grouting for cast-iron frame to chimney.

F. Waterproofing: Apply waterproofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. Waterproofing materials and installation are specified in Division 07 Section "[Elastomeric Sheet Waterproofing] [Thermoplastic Sheet Waterproofing]." After ducts have been connected and grouted, and before backfilling, waterproof joints and connections and touch up abrasions and scars. Waterproof exterior of manhole chimneys after mortar has cured at least three days.

G. Hardware: Install removable hardware, including pulling eyes, cable stanchions, and cable arms, and insulators, as required for installation and support of cables and conductors and as indicated.

H. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8 inches for manholes and 2 inches for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.

I. Warning Sign: Install "Confined Space Hazard" warning sign on the inside surface of each manhole cover.

J. Install ground rod before placing manhole lid.

## 3.6 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of ducts, and seal joint between box and extension as recommended by the manufacturer.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas and trafficways, set so cover surface will be flush with finished grade. Set covers of other handholes 1 inch above finished grade.

D. Install handholes and boxes with bottom below the frost line.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.

F. Field-cut openings for ducts and conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

G. For enclosures installed in asphalt paving and subject to occasional, non-deliberate, heavy-vehicle loading, form and pour a concrete ring encircling, and in contact with, enclosure and with top surface screeded to top of box cover frame. Bottom of ring shall rest on compacted earth.

1. Concrete: 4500 psi, 28-day strength, complying with Division 03 Section "Cast-in-Place Concrete," with a troweled finish.
2. Dimensions: 10 inches wide by 12 inches deep.

## 3.7 GROUNDING

A. Ground underground ducts and utility structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Install ground rod before placing manhole lid.

## 3.8 FIELD QUALITY CONTROL

A. Perform the following tests and inspections and prepare test reports:

1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.
2. Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.
3. Test manhole and handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Correct deficiencies and retest as specified above to demonstrate compliance.

## 3.9 CLEANING

A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

B. Clean internal surfaces of manholes, including sump. Remove foreign material.

END OF SECTION 260543

# SECTION 260544 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 26.

### 1.2 SUMMARY

A. Section Includes:

1. Sleeves for pathway and cable penetration of non-fire-rated construction walls and floors.
2. Sleeve-seal systems.
3. Sleeve-seal fittings.
4. Grout.
5. Silicone sealants.

### 1.3 ACTION SUBMITTALS

A. Product Data: For each type of product specified in this section.

B. LEED Submittals:

1. Product Data for Credit EQ 4.1: For sealants, documentation including printed statement of VOC content.

### 1.4 WARRANTY/GUARANTEE

A. See Division 26 Specification Section “Basic Electrical Requirements’ for warranty and guarantee requirements.

## PART 2 - PRODUCTS

### 2.1 SLEEVES

A. Wall Sleeves:

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

C. Sleeves for Rectangular Openings:

1. Material: Galvanized-steel sheet.
2. Minimum Metal Thickness:

a. For sleeve cross-section rectangle perimeter less than fifty (50) inches and with no side larger than sixteen (16) inches, thickness shall be 0.052 inch.
b. For sleeve cross-section rectangle perimeter fifty (50) inches or more and one or more sides larger than sixteen (16) inches, thickness shall be 0.138 inch.

### 2.2 SLEEVE-SEAL SYSTEMS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and pathway or cable.

1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

a. Advance Products & Systems, Inc.
b. CALPICO, Inc.
c. Metraflex Company (The).
d. Pipeline Seal and Insulator, Inc.
e. Proco Products, Inc.

2. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
3. Pressure Plates: Stainless steel.
4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Presealed Systems.

2.4 GROUT

A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.

B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

C. Design Mix: 5,000-psi, twenty eight (28) day compressive strength.

D. Packaging: Premixed and factory packaged.

2.5 SILICONE SEALANTS

A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
2. Sealant shall have VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Silicone Foams: Multi-component, silicone-based, liquid elastomers that, when mixed, expand and cure in place to produce a flexible, non-shrinking foam.

**PART 3 - EXECUTION**

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Comply with NECA 1.

B. Comply with NEMA VE 2 for cable tray and cable penetrations.

C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:

1. Interior Penetrations of Non-Fire-Rated Walls and Floors:

a. Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants."
b. Seal space outside of sleeves with mortar, grout or silicone. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.

2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
3. Size pipe sleeves to provide one quarter (1/4) inch annular clear space between sleeve and pathway or cable unless sleeve seal is to be installed
4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. De-burr after cutting.
5. Install sleeves for floor penetrations. Extend sleeves installed in floors two (2) inches above finished floor level. Install sleeves during erection of floors.

D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:

1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.

E. Roof-Penetration Sleeves: Seal penetration of individual pathways and cables with flexible boot-type flashing units applied in coordination with roofing work to maintain any existing warranties

F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using PVC or steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

G. Underground, Exterior-Wall and Floor Penetrations: Install PVC or steel pipe sleeves. Size sleeves to allow for one (1) inch annular clear space between pathway or cable and sleeve for installing sleeve-seal system.

## 3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at pathway entries into building.

B. Install type and number of sealing elements recommended by manufacturer for pathway or cable material and size. Position pathway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pathway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

## 3.3 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 260544

# SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 26.

### 1.2 SUMMARY

A. Section Includes:

1. Identification for raceways.
2. Identification of power and control cables.
3. Identification for conductors.
4. Underground-line warning tape.
5. Warning labels and signs.
6. Instruction signs.
7. Equipment identification labels.
8. Miscellaneous identification products.

### 1.3 SUBMITTALS

A. Product Data: For each electrical identification product indicated.

B. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.

C. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.

### 1.4 QUALITY ASSURANCE

A. Comply with ANSI A13.1 and IEEE C2.

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

D. Comply with ANSI Z535.4 for safety signs and labels.

E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.5 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

C. Coordinate installation of identifying devices with location of access panels and doors.

D. Install identifying devices before installing acoustical ceilings and similar concealment.

1.6 WARRANTY/GUARANTEE

A. See Division 26 Specification Section “Basic Electrical Requirements’ for warranty and guarantee requirements.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. LEM Products, Inc.
2. Panduit Corp.
3. Brady
4. Approved Equal

2.2 POWER RACEWAY IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.

B. Colors for Raceways Carrying Circuits at 600 V or Less:

1. Black letters on an orange field.

2. Legend: Indicate voltage and system or service type.

C. Colors for Raceways Carrying Circuits at More Than 600 V:

1. Black letters on an orange field.
2. Legend: "DANGER CONCEALED HIGH VOLTAGE WIRING" with 3-inch-high letters on twenty (20) inch centers.

D. Self-Adhesive Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

E. Tape and Stencil for Raceways Carrying Circuits More Than 600 V: four (4) inch- wide black stripes on ten (10) inch centers diagonally over orange background that extends full length of raceway or duct and is twelve (12) inches wide. Stop stripes at legends.

## 2.3 ARMORED AND METAL-CLAD CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

B. Colors for Raceways Carrying Circuits at 600 V and Less:

1. Black letters on an orange field.
2. Legend: Indicate voltage and system or service type.

C. Colors for Raceways Carrying Circuits at More Than 600 V:

1. Black letters on an orange field.
2. Legend: "DANGER CONCEALED HIGH VOLTAGE WIRING" with three (3) inch- high letters on twenty (20) inch centers.

D. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

## 2.4 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

B. Colored Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label. Tape shall not be less than 3 mils thick by 1 inch wide.

## 2.5 CONDUCTOR IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3- mils thick by one (1) to two (2) inches wide.

## 2.6 FLOOR MARKING TAPE

A. Two (2) inch- wide, 5-mil pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

## 2.7 UNDERGROUND-LINE WARNING TAPE

A. Tape:

1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
2. Printing on tape shall be permanent and shall not be damaged by burial operations.
3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.

B. Color and Printing:

1. Comply with ANSI Z535.1 through ANSI Z535.5.
2. Inscriptions for “RED”-Colored Tapes: “ELECTRIC LINE, HIGH VOLTAGE”.
3. Inscriptions for “ORANGE”-Colored Tapes: “TELEPHONE CABLE”, “CATV CABLE”, “COMMUNICATIONS CABLE”, “OPTICAL FIBER CABLE”.

C. Tag: Type I:

1. Pigmented polyolefin, bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
2. Thickness: 4 mils.
3. Weight: 18.5 lb/1000 sq. ft.
4. Three (3) Inch Tensile According to ASTM D 882: 30 lbf, and 2,500 psi.

## 2.8 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Interior Baked-Enamel Warning Signs:

1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
2. One quarter (1/4) inch grommets in corners for mounting.
3. Nominal size, seven (7) inches by ten (10) inches.

C. Exterior Metal-Backed, Butyrate Warning Signs:

1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing; and with colors, legend, and size required for application.
2. One quarter (1/4) inch grommets in corners for mounting.
3. Nominal size, ten (10) inches by fourteen (14) inches.

D. Warning label and sign shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

## 2.9 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum one sixteenth (1/16) inch thick for signs up to twenty (20) sq. inches and one eighth (1/8) inch thick for larger sizes.

1. Engraved legend with black letters on white face.
2. Punched or drilled for mechanical fasteners.
3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.
4. Minimum letter height shall be three eighth (3/8) inch.

## 2.10 EQUIPMENT IDENTIFICATION LABELS

A. Stenciled Legend: In non-fading, waterproof, black ink or paint. Minimum letter height shall be one (1) inch.

## 2.11 CABLE TIES

A. General-Purpose Cable Ties: Fungus inert, self extinguishing, one (1) piece, self locking, Type 6/6 nylon.

1. Minimum Width: Three sixteenth (3/16) inch.

2. Tensile Strength at 73ºF, According to ASTM D 638: 12,000 psi.
3. Temperature Range: -40ºF to + 185ºF.
4. Color: "BLACK" except where used for color-coding.

2.12 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in Division 09 painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

**PART 3 - EXECUTION**

3.1 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Apply identification devices to surfaces that require finish after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

F. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two (2) color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at fifty (50) foot maximum intervals in straight runs, and at twenty five (25) foot maximum intervals in congested areas. List typical color codes for systems, i.e. fire alarm, "RED"; security, "BLUE" and "YELLOW"; etc.

G. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:

1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.

H. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at six (6) inches to eight (8) inches

below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds sixteen (16) inches overall.

I. Painted Identification: Comply with requirements in Division 09 painting Sections for surface preparation and paint application.

3.2 IDENTIFICATION SCHEDULE

A. Concealed Raceways, Duct Banks, more than 600 V, within Buildings: Tape and stencil four (4) inch wide black stripes on ten (10) inch centers over orange background that extends full length of raceway or duct and is twelve (12) inches wide. Stencil legend "DANGER CONCEALED HIGH VOLTAGE WIRING" with three (3) inch- high black letters on twenty (20) inch centers. Stop stripes at legends. Apply to the following finished surfaces:

1. Floor surface directly above conduits running beneath and within twelve (12) inches of a floor that is in contact with earth or is framed above unexcavated space.
2. Wall surfaces directly external to raceways concealed within wall.
3. Accessible surfaces of concrete envelope around raceways in vertical shafts, exposed in the building, or concealed above suspended ceilings.

B. Accessible Raceways, Armored and Metal-Clad Cables, More Than 600 V: Self-adhesive vinyl labels. Install labels at ten (10) foot maximum intervals.

C. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30 A, and 120 V to ground: Identify with self-adhesive vinyl label. Install labels at ten (10) foot maximum intervals.

D. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall include panel and circuit information.

1. Emergency Power – “RED”
2. UPS
3. Fire Alarm System – “RED”
4. Fire-Suppression Supervisory and Control System – “RED” and “YELLOW”
5. Security – “BLUE” and “YELLOW”
6. Mechanical and Electrical Supervisory Systems – “GREEN” and “BLUE”
7. Telecommunication System – “ORANGE” and “YELLOW”
8. Control Wiring – “GREEN” and “RED”

E. Power-Circuit Conductor Identification, 600 V or Less: For conductors 1/0 and larger in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor

tape to identify the source and circuit number for each set of conductors. For single phase conductors, identify each phase.

1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded feeder and branch-circuit conductors.

   a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG.

   b. Colors for 208/120-V Circuits:

      1) Phase A: "BLACK".
      2) Phase B: "RED".
      3) Phase C: "BLUE".

   c. Colors for 480/277-V Circuits:

      1) Phase A: "BROWN".
      2) Phase B: "ORANGE".
      3) Phase C: "YELLOW".

F. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of six (6) inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

G. Install instructional sign including color-code for grounded and ungrounded conductors using adhesive-film-type labels.

H. Conductors to Be Extended in the Future: Attach write-on tags to conductors and list source.

I. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.

1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.

J. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.

1. Limit use of underground-line warning tape to direct-buried cables.

2. Install underground-line warning tape for both direct-buried cables and cables in raceway.

K. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

L. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels.

1. Comply with 29 CFR 1910.145.
2. Identify system voltage with black letters on an orange background.
3. Apply to exterior of door, cover, or other access.
4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:

a. Power transfer switches.
b. Controls with external control power connections.
c. DC Panelboards

M. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.

N. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum three eighths (3/8) inch- high letters for emergency instructions at equipment used for power transfer and/or load shedding.

O. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Labeling Instructions:

a. Indoor Equipment: Engraved, laminated acrylic or melamine label or Stenciled legend 4 inches high. Unless otherwise indicated, provide a single line of text with one half (1/2) inch high letters on one and one half (1-1/2) inch- high label; where two (2) lines of text are required, use labels two (2) inches high.
b. Outdoor Equipment: Stenciled legend four (4) inches high.

c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
d. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.

2. Equipment to Be Labeled:

a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be laminated acrylic or melamine label.
b. Enclosures and electrical cabinets - laminated acrylic or melamine labels.
c. Access doors and panels for concealed electrical items laminated acrylic or melamine labels.
d. Switchgear – stencil and paint
e. Switchboards – stencil and paint
f. Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary – stencil and paint.
g. Substations – stencil and paint.
h. Emergency system boxes and enclosures – stencil and paint.
i. Motor-control centers – stencil and paint.
j. Enclosed switches – laminated acrylic or melamine label.
k. Enclosed circuit breakers – laminated acrylic or melamine label.
l. Enclosed controllers – laminated acrylic or melamine label.
m. Variable-speed controllers – laminated acrylic or melamine label.
n. Push-button stations – laminated acrylic or melamine label.
o. Power transfer equipment – laminated acrylic or melamine label.
p. Contactors – laminated acrylic or melamine label.
q. Remote-controlled switches, dimmer modules, and control devices – laminated acrylic or melamine label.
r. Battery-inverter uni – laminated acrylic or melamine label
s. Battery racks – laminated acrylic or melamine label. Power-generating units – stencil and paint.
t. Communication Cabinets/Racks – laminated acrylic or melamine label.
u. Security Cabinets – laminated acrylic or melamine label.
v. Fire Alarm and Annunciator Cabinets – laminated acrylic or melamine label.
w. Control System Cabinets – laminated acrylic or melamine label.
x. Monitoring and control equipment – laminated acrylic or melamine label.
y. UPS equipment – laminated acrylic or melamine label.
z. Each receptacle, light switches and receptacles mounted in surface raceways shall be neatly marked on the inside cover with indelible marker identifying the panel and breaker from which it is fed and durable markers or tag inside outlet box. This to ensure the correct covers are restored after

room renovations and/or painting. In addition to marking circuit identification inside the cover, also provide laminated label with circuit number on device cover plates. Provide white background label with black bold lettering.

END OF SECTION 260553

# SECTION 260800 – COMMISSIONING ELECTRICAL SYSTEMS

## PART 1 - GENERAL

### 1.1 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 and all other sections of Division 26.

B. The OPR and BOD documentation are included by reference for information only.

### 1.2 SUMMARY

A. This section includes the requirements for commissioning the electrical systems, assemblies and equipment.

B. System Description: The CxA will be responsible for developing pre-functional checklists and Functional Performance Test scripts for the entire electrical system. The test scripts should not only include the individual equipment but the interaction of the entire system. The CxA shall coordinate with the Owner to develop limitations to building outages and incorporate these limitations into the commissioning plan.

### 1.3 DESCRIPTION

A. The following equipment and/or accessories shall be commissioned as part of this project:

1. Medium Voltage Service Electrical Systems.
2. Secondary Service Electrical Systems.
3. Distribution and Branch Circuit Panelboards.
4. Exterior Lighting Fixtures and Controls.
5. Equipment Monitoring/Metering and Alarm System.
6. AC Motors.
7. Grounding Equipment and Building Grounding System.
8. Security System.
9. Emergency Generators and Distribution System.
10. Switchgear Control System

### 1.4 SUBMITTALS

A. Refer to Division 01 Section "General Commissioning Requirements" for CxA's role.

B. Refer to Division 01 Section "Submittal Procedures" for specific requirements. Refer to Division 01 Section "General Commissioning Requirements" for additional submittal requirements related to submittals of equipment to be commissioned and Cx specific submittals.

1.5 COORDINATION

A. Refer to Division 01 Section "General Commissioning Requirements" for requirements pertaining to coordination during the commissioning process.

1.6 GENERAL DOCUMENTATION

A. With assistance from the installing contractors, the CxA will prepare Pre-Functional Checklists for all commissioned components, equipment, and systems.

**PART 2 - PRODUCTS**

2.1 TEST EQUIPMENT

A. Refer to Division 01 Section "General Commissioning Requirements" for requirements pertaining to testing equipment.

**PART 3 - EXECUTION**

3.1 TESTING PREPARATION

A. Certify in writing to the CxA that electrical systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.

B. Place systems, subsystems, and equipment into operating mode to be tested.

C. Inspect and verify the position of each device and interlock identified on checklists.

D. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

3.2 GENERAL TESTING REQUIREMENTS

A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.

B. Scope of electrical testing shall include lighting controls and power riser inspections.

C. Test all operating modes and verify proper response of controllers and sensors.

D. The CxA along with the lighting contractor shall prepare detailed testing plans, procedures, and checklists for applicable lighting systems, subsystems, and equipment.

E. Tests will be performed using design conditions whenever possible.

3.3 ELECTRICAL SYSTEMS, SUBSYSTEMS, AND EQUIPMENT TESTING PROCEDURES

A. Procedures: Where applicable follow manufacturer's written procedures. If no procedures are prescribed by the manufacturer, proceed as follows:

1. Electrical Distribution Systems: Includes panels and circuit breakers for power and lighting.

   a. Verify that all panels and components have been installed correctly, are accessible and operate as intended.
   b. Verify that specified tests are complete.

2. Electrical Equipment: Includes lighting controls, emergency generator, and automatic transfer switch,.

   a. Verify that all equipment has been installed in accordance with the manufactures recommendations and all equipment can be easily accessed for maintenance and operates as intended.
   b. Verify that all connections, controls, and accessories have been installed correctly and operates as intended.
   c. Verify that all equipment test, training, and startup procedures have been completed per the specifications.
   d. Operate equipment as intended to ensure the design conditions can be obtained.

END OF SECTION 260800

# SECTION 260913 - ELECTRICAL POWER MONITORING

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 26.

### 1.2 SUMMARY

A. Section includes the following for monitoring and control of electrical power system:

1. Communication network and interface modules for RS-485, Modbus TCP/IP and IEEE 802.3 data transmission protocols.
2. Power monitoring equipment (Power Monitors).
3. Programming and Software.

B. This specification contains hardware and software requirements for the metering network only. For the switchgear and generator control systems refer to specification 262313 Switchgear Control System. The metering system shall provide remote and local monitoring of the system only. The metering system shall receive input from the control system but the control system shall not accept input from the metering system. The metering system shall not have control capability of any switchgear. The metering system will communicate over the campus network. The switchgear control system shall communicate over a new dedicated network provided under this project.

C. The campus has an existing Square D metering software package (EcoStruxure Power Monitoring Expert (PME)) that monitors the electric meters throughout the campus. This software system shall be updated to the latest version and also updated to include the new meters that are being provided on campus. In addition, the contractor shall contract with Square D to update the metering software to include single line representations of the North Switching Station, Howard Hall 15kV Switchgear, Howard Hall 15kV Generator Switchgear, Howard Hall 480V Switchgear, and the BRB 480V Switchgear. The system shall be expandable to include the future South Switching Station.

### 1.3 DEFINITIONS

A. Ethernet: Local area network based on IEEE 802.3 standards.

B. Firmware: Software (programs or data) that has been written onto read-only memory (ROM). Firmware is a combination of software and hardware. Storage media with ROMs that have data or programs recorded on them are firmware.

C. HTML: Hypertext markup language.

D. I/O: Input/output.

E. KY Pulse: A term used by the metering industry to describe a method of measuring consumption of electricity that is based on a relay changing status in response to the rotation of the disk in the meter.

F. LAN: Local area network; sometimes plural as "LANs."

G. LCD: Liquid crystal display.

H. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or remote-control, signaling and power-limited circuits.

I. Modbus TCP/IP: An open protocol for exchange of process data.

J. Monitoring: Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.

K. PC: Personal computer; sometimes plural as "PCs."

L. rms: Root-mean-square value of alternating voltage, which is the square root of the mean value of the square of the voltage values during a complete cycle.

M. RS-232: A TIA standard for asynchronous serial data communications between terminal devices.

N. RS-485: A TIA standard for multipoint communications using two twisted-pairs.

O. TCP/IP: Transport control protocol/Internet protocol incorporated into Microsoft Windows.

P. THD: Total harmonic distortion.

Q. UPS: Uninterruptible power supply; used both in singular and plural context.

R. WAN: Wide area network.

## 1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1. Attach copies of approved Product Data submittals for products (such as switchboards and switchgear) that describe power monitoring and control features to illustrate coordination among related equipment and power monitoring and control.

B. Shop Drawings: For power monitoring and control equipment. Include plans, elevations, sections, details, and attachments to other work.

1. Outline Drawings: Indicate arrangement of components and clearance and access requirements.
2. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines.
3. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
4. Wiring Diagrams: For power, signal, and control wiring. Coordinate nomenclature and presentation with a block diagram.

## 1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Field quality-control reports.

C. Other Informational Submittals:

1. Manufacturer's system installation and setup guides, with data forms to plan and record options and setup decisions.

## 1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For power monitoring and control units, to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Operating and applications software documentation.
2. Software licenses.
3. Software service agreement.
4. PC installation and operating documentation, manuals, and software for the PC and all installed peripherals. Software shall include system restore, emergency boot diskettes, and drivers for all installed hardware. Provide separately for each PC.

5. Hard copies of manufacturer's specification sheets, operating specifications, design guides, user's guides for software and hardware, and PDF files on CD-ROM of the hard-copy submittal.

B. Software and Firmware Operational Documentation:

C. Software licenses and upgrades required by and installed for operating and programming digital and analog devices.

## 1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Addressable Relays: One for every 10 installed. Furnish at least one of each type.
2. Data Line Surge Suppressors: One for every 10 of each type installed. Furnish at least one of each type.

## 1.8 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

B. Manufacturer Qualifications: A firm experienced in manufacturing power monitoring and control equipment similar to that indicated for this Project and with a record of successful in-service performance.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

## 1.9 COORDINATION

A. Coordinate features of distribution equipment and power monitoring and control components to form an integrated interconnection of compatible components.

1. Match components and interconnections for optimum performance of specified functions.

B. Coordinate Work of this Section with those in Sections specifying distribution components that are monitored or controlled by power monitoring and control equipment.

1.10 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Through Schneider Electric, provide two (2) years of PowerLogic Technical Support for the UMB Power Monitoring Expert (PME) electrical metering system that will begin on the project's date of substantial completion.

B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include the operating systems. Upgrade shall include new or revised licenses for use of software.

1. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

1.11 WARRANTY/GUARANTEE

A. See Division 26 Specification Section "Basic Electrical Requirements' for warranty and guarantee requirements.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product by Schneider Electric – Power Management Operation.

2.2 FUNCTIONAL DESCRIPTION

A. Software: Existing Square D software shall be updated to include trending of all new meters on this project. In addition, new schematic representations showing single line drawings with breaker status, and alarm conditions, such as breaker trips, shall be provided for the North Switching Station, Howard Hall 15kV SWGR, Howard Hall 15kV Generator SWGR, Howard Hall 480V SWGR, and BRB 480V SWGR. All new meters will tie into the existing campus communication network.

1. Contractor shall contact Square D for work involving upgrading existing Power Monitoring system. Square-D Owner Representative is: Jeff Pitzer, jeff.pitzer@schneider-electric.com. 717-495-2507.

2.3 SYSTEM REQUIREMENTS

A. Existing Server: Existing server is located in the Health Sciences Library. Server shall be upgraded to include all new meters and workstations.

B. Existing PC Based Work System: Existing workstations shall be upgraded to include all new meters and single lines as described in this specification.

C. Additional PC Based Work Systems: Install new remote PC-based workstation in the following locations. Both locations have access to the campus Ethernet network. PC Based workstations shall have access to metering logs and single line diagrams. The workstations shall be furnished by the owner and given to the Contractor to install.
   1. Pearl St. AF-OM Building, Electrical Supervisor's office.
   2. Electricians Shop, Pearl St Garage.

## 2.4 WORKSTATION HARDWARE

A. New workstations will be purchased by the owner and installed by the contractor. Section is provided for reference only. Exact workstations might not match what is listed in this section.

B. Environmental Conditions: System components shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

   1. Indoor installation in spaces that have environmental controls to maintain ambient conditions of $36^0$F to $122^0$F dry bulb and 20% to 90% relative humidity, noncondensing.

C. Computer: Standard unmodified PC of modular design, designed for the latest version of Windows operating system.

   1. Memory: 16GB of usable installed memory.
   2. Real-Time Clock. Automatic time correction once every twenty four (24) hours by synchronizing clock with the Time Service Department of the U.S. Naval Observatory.
   3. Ports: Two RS-232-F serial ports for general use; one parallel port; four USB ports
   4. Replaceable graphics board.
   5. LAN Adapter Card.
   6. Sound Card: For playback and recording of digital WAV sound files associated with audible warning and alarm functions.
   7. Color Monitor: WXGA TFT, not less than 18 inches, LCD type.
   8. Keyboard: US English.
   9. Mouse: Standard.
   10. Minimum Disk Storage: 7,200 rpm hard drive or solid state drive, 500GB minimum.

11. CD-RW/DVD-ROM Drive.

2.5 POWER MONITORING EQUIPMENTCIRCUIT MONITORS – Advanced (ION 7400 & ION 9000T with small screen display)

1. Measured Values

a) The following metered values shall be measured by the Circuit Monitor. In addition, the circuit monitor shall record and save in nonvolatile memory the minimum and maximum values of all listed values since last reset. The circuit monitor shall also record and save in nonvolatile memory the interval minimum, maximum, and average of any of the values pre-defined over a user specified interval.

1) Real-Time Readings

(a) Current (Per-Phase, N, G, 3-Phase Avg, Apparent rms, %Unbalanced)
(b) Voltage (L–L Per-Phase, L-L 3-Phase Avg, L–N Per-Phase, 3-Phase Avg, Neutral to Ground, % unbalanced)
(c) Real Power (Per-Phase, 3-Phase Total)
(d) Reactive Power (Per-Phase, 3-Phase Total)
(e) Apparent Power (Per-Phase, 3-Phase Total)
(f) Power Factor (True)(Per-Phase, 3-Phase Total)
(g) Power Factor (Displacement)(Per-Phase, 3-Phase Total)
(h) Frequency
(i) Temperature (Internal Ambient)
(j) THD (Current and Voltage)
(k) K-Factor (Per-Phase)

2) Energy Readings

(a) Accumulated Energy (Real kWh, Reactive kVARh, Apparent kVAh) (Signed/Absolute)
(b) Incremental Energy (Real kWh, Reactive kVARh, Apparent kVAh) (Signed/Absolute)
(c) Conditional Energy (Real kWh, Reactive kVARh, Apparent kVAh) (Signed/Absolute)
(d) Reactive Energy by Quadrant

3) Demand Readings

(a) Demand Current (Per-Phase present, 3-Phase Avg, Neutral)

(i) Last complete interval

(ii) Peak

(b) Demand Voltage (L-N, L-L, Per-Phase, 3-Phase avg.)

(i) Last complete interval
(ii) Minimum
(iii) Peak

4) Average Power Factor (True), (3-Phase total)

(a) Last complete interval
(b) Coincident with kW peak
(c) Coincident with kVAR peak
(d) Coincident with kVA peak

5) Demand Real Power (3-Phase Total)

(a) Last complete interval
(b) Predicted
(c) Peak
(d) Coincident kVA Demand
(e) Coincident kVAR Demand

6) Demand Reactive Power (3-Phase Total)

(a) Last complete interval
(b) Predicted
(c) Peak
(d) Coincident kVA demand
(e) Coincident kW demand

7) Demand Apparent Power (3-Phase Total)

(a) Last complete interval
(b) Predicted
(c) Peak
(d) Coincident kVA demand
(e) Coincident kW demand

8) Power Analysis Values

(a) THD – Voltage, Current (3-Phase, Per-Phase, Neutral)
(b) THD - Voltage, Current (3-Phase, Per-Phase, Neutral)
(c) Total Demand Distortion
(d) K-Factor (Per-Phase)
(e) Crest Factor (Per-Phase)
(f) Displacement Power Factor (Per-Phase, 3-Phase)
(g) Fundamental Voltage, Magnitude and Angle (Per-Phase)

(h) Fundamental Currents, Magnitude and Angle (Per-Phase)
(i) Fundamental Real Power (Per-Phase, 3-Phase)
(j) Fundamental Reactive Power (Per-Phase)
(k) Harmonic Power ((Per-Phase, 3-Phase)
(l) Phase Rotation
(m) Unbalance (Current and Voltage)
(n) Harmonic Magnitudes & Angles (Per-Phase)
(o) Distortion Power
(p) Distortion Power Factor

b) The current and voltage signals shall be digitally sampled at a rate high enough to provide true rms accuracy to the 255th harmonic (based on fundamental of 50/60 Hz).

c) The following metered values as well as the minimum and maximum instantaneous readings since last reset shall be communicated by the Circuit Monitor:

1) Frequency
2) Temperature
3) Current, per phase rms and neutral (if applicable)
4) Current, 3-phase average rms
5) Current, apparent rms
6) Voltage, phase-to-phase and phase-to-neutral
7) Voltage unbalance, phase-to-phase and phase-to-neutral
8) Power factor, per phase
9) Power factor, 3-phase total
10) Real power, per phase and 3-phase total
11) Reactive power, per phase and 3-phase total
12) Apparent power, per phase and 3-phase total
13) Demand current, per phase and three-phase average
14) Demand real power, three-phase average
15) Demand reactive power, three-phase average
16) Demand apparent power, three-phase average
17) Accumulated energy, (MWh, MVAH, and MVARh)
18) Reactive energy, (VARh by quadrant)
19) Total Harmonic Distortion (THD), voltage and current, per phase
20) K-factor, per phase

2. Demand

a) All power demand calculations shall be done by any one of the following calculation methods, selectable by the user:

1) Thermal demand is calculated using a sliding window and is updated every second. The sliding window length shall be defined by the user from one (1) minute to sixty (60) minutes, with one (1) minute increments.
2) Block interval, with optional sub-intervals. The window length shall be set by the user from one minute (1) to sixty (60) minutes in one (1) minute intervals. The user shall be able to set the sub-interval length from one (1) minute to thirty (30) minutes in one (1) minute intervals.
3) External Pulse Synchronization, utilizing a synch pulse provided externally. An optional status input shall be used to sense the pulse.
4) Sliding block interval with continuous sliding one (1) second subintervals.

b) The default demand calculation method shall be a fifteen (15) minute continuous sliding block.
c) The following demand readings shall be reported by the Circuit Monitor:

1) Average demand current, per phase
2) Peak demand current, per phase
3) Average demand for real power, reactive power, and apparent power
4) Predicted demand for real power, reactive power, and apparent power
5) Peak demand for real power, reactive power, and apparent power

d) The Circuit Monitor shall also provide a generic demand capability to provide demand calculation on any metered parameter.
e) Each Circuit Monitor shall be capable of receiving a broadcast message over the communications network that can be used to synchronize demand calculations by several Circuit Monitors. This message need not be addressed specifically to any one Circuit Monitor.

3. Sampling

a) The current and voltage signals shall be digitally sampled at a rate high enough to provide true rms accuracy to the 255th harmonic (fundamental of 60 Hz).

4. Harmonics

a) Advanced harmonic information shall be available via the Circuit Monitor. This shall include the calculation of the harmonic magnitudes and angles for each phase voltage and current through the 255th harmonic.

b) This information shall be available for all three phases, current and voltage, plus the neutral current. To ensure maximum accuracy for analysis, the current and voltage information for all phases shall be obtained simultaneously from the same cycle.

c) The Circuit Monitor shall have a minimum of 16k of on board memory to log harmonic magnitudes and angles.

d) The harmonic magnitude shall be reported as a percentage of the fundamental or as a percentage of any Circuit Monitor may be applied in three-phase, three- or four-wire systems. A fourth CT input shall be available to measure neutral or ground current. If the fourth CT is not used, then a residual current shall be calculated by vectoral addition of the phase currents. In four-wire connections the Circuit Monitor shall utilize the circuit neutral common reference and not earth ground, to provide metering accuracy.

e) Harmonic power flows will be provided up to the 41st harmonic for real, reactive and apparent power.

5. Transients

a) The Circuit Monitor shall be able to detect and capture transients up to 10,000 Vpeak line to line with a duration as short as two hundred (200) nanoseconds when equipped with a Transient Module.

6. Flicker

a) The Circuit Monitor shall detect and measure the flicker (50Hz or 60Hz) of an electrical system based on the IEC Standard 61000-4-15 (or IEEE 1453) when equipped with a Transient Module.

b) The Circuit Monitor shall measure three levels of Flicker:

1) Instantaneous
2) Short-term
3) Long-term

c) The user shall have the ability to view the graphical time-trend of Flicker magnitude in a semi-logarithmic format when equipped with a communications card.

7. EN50160 Evaluation

a) The Circuit Monitor shall include EN50160 evaluations. This capability is characterized by the evaluation of certain power quality parameters: frequency, magnitude of the supply voltage, supply voltage variations, rapid voltage changes, supply voltage dips, short interruptions of the supply voltage, long interruptions of the supply voltage, temporary power frequency overvoltages, transient overvoltages, supply voltage unbalance, and harmonic voltage.

b) The Circuit Monitor shall be capable of reporting EN50160 evaluation data in the following formats: summary of active evaluations, summary of evaluation status, detailed information for each evaluated parameter, detailed information for each abnormal event

c) The user shall be able to reset EN50160 evaluations statistics as required.

8. Accuracy

a) The Circuit Monitors shall accept metering inputs of up to 600Vac direct connection or from industry standard instrument transformers (120 VAC secondary PTs and 5 A secondary CTs). Connection to 480Y/277 VAC circuits shall be possible without use of PTs.

b) PT primaries through 1.2 MV shall be supported

c) CT primaries through 32 kA shall be supported

d) The Circuit Monitor shall be accurate to 0.04% of reading plus/minus 0.025% of full scale for voltage and current metering and 0.08% of reading plus 0.025% for power.

e) The Circuit Monitor's energy readings shall meet the revenue accuracy requirements of ANSI C12.20 0.2 class and IEC 60687 0.2S class metering.

f) No annual re-calibration by users shall be required to maintain published accuracy.

g) Voltage and current for all phases shall be sampled simultaneously to assure high accuracy in conditions of low power factor or large waveform distortions (harmonics).

9. Waveform Capture

a) All Circuit Monitors shall include current and voltage waveform capture capability. Waveform capture shall be user selectable for sixteen (16) cycles to five hundred twelve (512) cycles of data. Or can be user specified up to thirty (30) seconds.

b) Waveform capture shall be initiated either from a Personal Computer Workstation (PCW) running the Power Monitoring and Control Systems software, or by the circuit monitor as a user defined response to an alarm condition.

c) Waveform capture manually triggered from the Power Monitoring and Control System software shall be captured at five hundred twelve (512) samples/cycle for one (1) cycle providing harmonic content up to the 255th harmonic for Ia, Ib, Ic, I4, Va, Vb, Vc, Vg.

d) Three types of waveform capture shall be available for response to an alarm condition:

1) Steady State shall be manually initiated and provide a resolution of five hundred twelve (512) samples/cycle.
2) Disturbance shall be initiated manually or by an alarm condition and allow the user to select a resolution of sixteen (16) to five hundred twelve (512) samples/cycle and a duration of nine hundred fifteen (915) to one (1) cycle.
3) Adaptive shall be initiated manually or by an alarm condition and allow the user to select a resolution of sixteen (16) to five hundred twelve (512) samples/cycle and a duration of one thousand three hundred twenty (1,320) to one (1) second.

e) The Circuit Monitor shall transmit the waveform samples over the network to the personal computer workstation for display, archival, and analysis.

f) Each voltage and current of all the phases shall be sampled concurrently so that proper phase relationships are maintained, so that harmonic flow analysis can be performed, and so that the effect of a disturbance can be observed on all phase voltages and currents.

g) Harmonic analysis performed on the captured waveforms shall resolve harmonics through the 255th using Power Monitoring and Control Software.

h) All waveforms must reflect actual circuit performance. Waveforms synthesized or composed over time shall not be acceptable.

10. Logging

a) Data logging may be accomplished either within the circuit monitor or at the PC Workstation, or both. Each circuit monitor shall be able to log data, alarms and events, and multiple waveforms. The monitors shall contain a minimum of 8MB of on-board nonvolatile memory, which can be field upgraded without requiring disassembly or removal the Circuit Monitor. On board data logs shall be communicated to the PC Workstation upon demand or at scheduled intervals. Logged information to be stored in each Circuit Monitor includes:

1) Up to fourteen (14) separate data logs shall be configurable by the user. Each log entry shall be date and time stamped. The type of data for the log shall be selected from a list of over one hundred fifty (150) monitored values. Each log entry shall be user configurable to consist of from one to over seventy five (75) values of instantaneous data. It shall be possible to set up each log to record data at independent user defined intervals. In addition, it shall be possible for a user to define an event or new min/max condition that will trigger log file entries.
2) Data logs can be configured by users to be Fill & Hold or Circular (FIFO).
3) A Min/Max log file shall include the time, date, and value for the minimum and maximum of each of the instantaneous metered values since last reset. As well as a Min/Max/Avg. log that records the minimum/maximum/average readings for pre-defined quantities at a user-specified interval.
4) An alarm and event log shall contain time, date, event information, and coincident information for each user defined alarm or event. This log shall have a capacity of up to one thousand (1,000) events.
5) Waveform logs shall store captured waveforms as defined by the user. Waveform log entries shall be scheduled at user defined interval, externally triggered, or forced in response to a user defined event. Waveform logs shall be either Fill & Hold or Circular (FIFO) as defined by the user.
6) The Power Monitoring and Control System software shall be available to enable the user to allocate onboard Circuit Monitor memory for each logging function.

11. Alarming

a) Alarm events shall be a combination of pre-configured from the factory events and user definable events Multiple levels of alarms can be configured for each metered parameter.
b) The following classes of events shall be available as alarm events:

1) Over/under current
2) Over/under voltage
3) Current imbalance
4) Phase loss, current
5) Phase loss, voltage
6) Wave Shape Alarm
7) Voltage imbalance
8) Over kVA
9) Over kW or kVAR into/out of load
10) Over/under frequency
11) Under power factor, true or displacement

12) Over THD
13) Over K-factor
14) Over demand, current or power
15) Reverse power
16) Phase reversal
17) Status Input change
18) End of incremental energy interval
19) End of demand interval
20) Over/under analog inputs
21) Current sag/swell
22) Voltage sag/swell
23) Transients (Where available)

c) For each over/under metered value alarm, the user shall be able to define a pick-up, drop-out, and delay.

d) The user will have the ability to alarm using a Waveshape Alarm feature based on user set thresholds by defining the following parameters:

1) Phase Voltage
2) Neutral Ground Voltage
3) Phase Current
4) Neutral Current

e) There shall be four alarm severity levels in order make it easier for the user to respond to the most important events first.

f) Indication of an alarm condition shall be given on the local display as well as reported to the Power Monitoring and Control System software.

g) The Circuit Monitor shall calculate key electrical parameters at 100ms intervals for the purpose of alarming and recording of data during an event. The recorded data shall be comprised of RMS readings for I, V, kW, kVAR, kVA, and True PF. 1-10 seconds of pre-event and up to five (5) minutes of post event data can be recorded.

12. Waveshape Alarm

a) The Circuit Monitor shall include waveshape alarm capability. This capability is characterized by the following features:

1) The Circuit Monitor shall be capable of continuously monitoring waveform anomalies in the following:

(a) Phase voltages
(b) Neutral to ground voltages
(c) Phase currents
(d) Neutral currents

b) Anomalous waveshape events less than 1/2 cycle in length shall be detected.

c) The user shall be able to set a threshold value and upper limit in the circuit monitor to determine if a waveshape event has occurred. The threshold and upper limit shall be user-defined values between zero (0) and one hundred (100). The threshold value is the limit at which a waveshape alarm will trigger. The upper limit defines the highest waveshape value that will trigger a waveshape alarm.

d) Upon detecting a disturbance, the Circuit Monitor shall be capable of:

1) Logging a waveform of the event all phase currents and voltages and/or a high-speed 100ms RMS event recording.
2) Recording the disturbance into an event log with a date and time stamp to the millisecond.
3) Causing an operator alarm at the PCW workstation.
4) Determining the source of the disturbance (upstream or downstream from the meter) and a statistical level of confidence (low, medium, high) of the accuracy of the source location.

13. Alarm Setpoint Learning (ASL)

a) Using SMS software (3.3.2 or greater), the user can enable the Series 4,000 Circuit Monitor to learn the characteristics of normal operation of metered values and select alarm setpoints based on this data.

b) The user is able to determine the quantities to be learned and the period of time for the learning process for standard-speed and high-speed analog alarms, disturbance alarms, and waveshape alarms.

c) The user can configure this feature using one of two (2) modes:

1) Fixed Learning: Initially configured user setpoints are used during the entire learning period.
2) Dynamic Learning: Initially configured user setpoints are temporarily replaced by learned setpoints at the interval specified by the user in SMS. The setpoints continue to be updated at the specified interval until the learning period expires.

d) The user can configure the duration of the learning period. If the learned setpoints do not change over a predefined period, the process can be stopped and the setpoints either installed or held for review.

14. Communications

a) The Circuit Monitor shall communicate via RS-232, RS-485, and Ethernet simultaneously.

b) The Circuit Monitor shall provide Modbus communications using Modbus TCP via an Ethernet network at 10/100Mbaud using UTP or Fiber connections. The Circuit Monitor shall provide the capability to communicate to thirty one (31) additional Modbus devices existing on RS-485 daisy chains and report data back to the PMCS application software or across the Ethernet network to other software applications.

c) The Circuit Monitor display shall provide an RS-232 communications port on board the metering module as well as an IR RS-232 communications port located on the display. The display port shall be completely accessible during normal operation and shall not require exposure of the operator to life-threatening voltage when in use. The operator shall be able to quickly connect a small Personal Computer (PC) to either the module port or the display port without use of tools or splices. Both the metering module port and the display port shall have all of the communication functionality of the standard hard-wired port. When a connection is made to either the metering module port or the display port, the Circuit Monitor shall continue simultaneous operation of all communication ports associated with the Circuit Monitor.

d) It shall be possible to field upgrade the firmware in the Circuit Monitor to enhance functionality. These firmware upgrades shall be done through either the display port or communication connection. No Circuit Monitor disassembly or changing of integrated circuit chips shall be required. It shall not be necessary to de-energize the circuit or the equipment to upgrade the firmware.

e) The circuit monitor shall allow communication to all ports simultaneously.

f) The circuit monitor shall have the option to serve data over the Ethernet network accessible through a standard web browser. Information shall be available from the circuit monitor and from Modbus slave devices connected downstream from the monitor. The monitor shall contain default pages from the factory and also have the ability for the user to create custom pages as needed.

g) The circuit monitor shall provide e-mail notification of any alarm condition that it detects.

h) Time synchronization to one (1) millisecond between monitors via GPS synchronization.

15. I/O Options

a) Circuit Monitor Input/Output Options: Input/Output options/modules shall be field replaceable. Circuit Monitors shall provide pre-configured I/O options and also provide I/O options to be configured as applicable to each installation as shown on the project drawings:

1) One solid state output suitable for KYZ pulse initiation; four solid state status inputs; three (10A) mechanical output relays

2) Four solid state status inputs; four analog inputs (4-20 mA)
3) Four inputs (32Vdc); 2 solid state outputs (60Vdc); 1 analog input (0-5Vdc); 1 analog output (4-20mA)
4) Eight solid state status inputs (120Vac)
5) Circuit Monitor shall provide configurable I/O options to include solid state input modules for 120Vac, 200Vac, and 32Vdc; solid state outputs modules for 120Vac, 240Vac, 60Vdc, 240Vdc; analog input modules for 0-5Vdc, 4-20mA; analog output module for 4-20mA.

16. Output Relay Control

a) Relay outputs shall operate either by user command sent over the communication link, or set to operate in response to user defined alarm event.
b) Output relays shall close in either a momentary or latched mode as defined by the user.
c) Each output relay used in a momentary contact mode shall have an independent timer that can be set by the user.
d) It shall be possible for individual relay outputs to be controlled by multiple alarms in a wired "OR" configuration.

17. Disturbance Detection

a) All Circuit Monitors noted on the project drawings shall include sag and swell detection capability. This capability is characterized by the following features:

1) The Circuit Monitor shall continuously monitor for disturbances in the currents and incoming voltage. There shall be zero (0) blind time; each cycle shall be individually monitored.
2) Disturbance events less than one half (1/2) cycle in length shall be detected.
3) The user shall be able to set a threshold and delay which shall be used by the circuit monitor to determine if an event has occurred. The threshold shall be user defined as either a fixed set point or relative set point. When using the relative set point, the Circuit Monitor will set the nominal current or voltage equal to its present average value. The Circuit Monitor will automatically adjust the nominal current and voltage values to avoid nuisance alarms caused by gradual daily variations of currents and voltages.

b) Upon detecting a disturbance, the Circuit Monitor shall be capable of :

1) Logging a waveform of the event all phase currents and voltages and/or a high-speed 100ms RMS event recording.

2) Operating any output relay on an optional I/O module.
3) Recording the disturbance into an event log with a date and time stamp to the millisecond.
4) Determining the direction of the cause of disturbance and categorize as "Upstream" from the meter or "Downstream" from the meter with an assigned confidence factor in the algorithm, then annunciate this determination through software.
5) Causing an operator alarm at the PCW workstation.

c) The user shall have the ability to display the voltage sag/swell events on ITIC or SEMI graphs to quantify the event with respect to accepted industry standards. If so desired the user shall also have the ability to view this information on custom web pages over the Internet when used with a communications card.

d) All data and waveform logs shall be communicated over the local area network or through the front panel communications port so that the user may view and analyze the data using the PMCS software and workstation.

e) The location of the source of the disturbance (upstream or downstream from the meter) may be provided for each event. A statistical level of confidence (low, medium, high) will be provided of the accuracy of the source's location.

18. Display

a) The Circuit Monitor display shall allow the user to select one (1) of six (6) languages to view on the screen:

1) English
2) French
3) Spanish.
4) Italian
5) Polish
6) German

b) The Circuit Monitor display shall also allow the user to select a date/time format and the ability to create additional screens for user-specified views and/or custom quantities without overwriting existing standard screens.

c) The Circuit Monitor display shall provide local access to the following metered quantities as well as the minimum and maximum value of each instantaneous quantity since last reset of min/max:

1) Current, per phase rms, 3-phase average and neutral (if applicable)
2) Voltage, phase-to-phase, phase-to-neutral, and 3-phase average (phase-to-phase and phase-to-neutral)
3) Real power, per phase and 3-phase total
4) Reactive power, per phase and 3-phase total

5) Apparent power, per phase and 3-phase total
6) Power factor, 3-phase total and per phase
7) Frequency
8) Demand current, per phase and three phase average
9) Demand real power, three phase total
10) Demand apparent power, three phase total
11) Accumulated Energy, (MWh and MVARh)
12) THD, current and voltage, per phase
13) K-factor, current, per phase

d) Reset of the following electrical parameters shall also be allowed from the Circuit Monitor display:

1) Peak demand current
2) Peak demand power (kW) and peak demand apparent power (kVA)
3) Energy (MWh) and reactive energy (MVARh)
4) Setup for system requirements shall be allowed from the Circuit Monitor display. Setup provisions shall include:
5) CT rating
6) PT rating
7) System type [three-phase, 3-wire] [three-phase, 4-wire]
8) Demand interval (5-60 min.)
9) Watt-hours per pulse

e) For ease in operator viewing, two displays are offered for local viewing of Circuit Monitor data. The liquid crystal display (LCD) shall include back lighting. The enhanced vacuum fluorescent display (VFD) shall be automatically activated by a proximity sensor as the operator approaches.

19. Programming

a) Where indicated on the drawings, the Circuit Monitors shall be designed to run customized programs to greatly expand the Circuit Monitor's functionality for the particular installation.
b) These programs shall be written in a circuit monitor programming language similar to a compiled "BASIC" language. It shall include the following capabilities:

1) Scheduled tasks
2) Event Tasks
3) Math functions including: add, subtract, multiple, divide, sine, cosine, square root, etc.
4) Logical functions including: AND, OR, XOR, NOT, shift, etc.
5) Loop commands
6) Compare statements

7) Counters and timers

c) The circuit monitor manufacturer shall offer custom programming services.

d) Changing programs shall not require any physical modifications to the Circuit Monitor, such as changing computer chips or cards. All changes shall be done via either of the communications ports.

e) Examples of custom programs would include:

1) Metering of specialized utility rate structures, including real time pricing and curtailable rates
2) Data reduction using smart data logging
3) Automatic monthly logging/reset of kWh and Peak Demand
4) Statistical profile analysis of metered quantities
5) ITIC/SEMI power quality analysis
6) Calculations for IEEE-519 verification
7) Metering of combined utilities: gas, water, steam, electric
8) Non-critical control schemes, such as load control or power factor correction, based on multiple conditions e.g. time of day and input status

20. Current/Voltage Inputs

a) The Circuit Monitors shall accept metering inputs of up to 600Vac direct connection or from industry standard instrument transformers (120 VAC secondary PTs and 5 A secondary CTs). Connection to 480Y/277 VAC circuits shall be possible without use of PTs.

b) PT primaries through 1.2 MV shall be supported

c) CT primaries through 32 kA shall be supported

d) The Circuit Monitor shall be accurate to 0.04% of reading plus/minus 0.025% of full scale for voltage and current metering and 0.08% of reading plus 0.025% for power.

e) The Circuit Monitor's energy readings shall meet the revenue accuracy requirements of ANSI C12.20 0.2 class metering.

f) No annual re-calibration by users shall be required to maintain published accuracy.

21. Feature Additions

a) It shall be possible to field upgrade the firmware in the Circuit Monitor to enhance functionality. These firmware upgrades shall be done through the communication connection and shall allow upgrades of individual meters or groups. No disassembly or changing of integrated circuit chips shall be required and it will not be necessary to de-energize the circuit or the equipment to perform the upgrade.

b) The Circuit Monitors shall be rated for an operating temperature range of -25$^0$C to 70$^0$C and have an over current withstand rating of 500 amps for one (1) second.
c) All setup parameters required by the Circuit Monitors shall be stored in nonvolatile memory and retained in the event of a control power interruption.
d) The Circuit Monitor shall be capable of being applied without modification at nominal frequencies of 50, 60, or 400 Hz.

e) The Circuit Monitor (CM4250) shall include anti-aliasing filters on both voltage and current metering inputs. These anti-aliasing filters are capable of having the corner frequency adjusted between 50Ha, 60Hz, or "off" modes.
f) The Circuit Monitor (CM4250) shall have a Cat IV overvoltage withstand rating on the voltage metering inputs.

22. The Circuit Monitor shall operate properly over a wide range of control power including 100-305 VAC or 100-300 VDC. Connections to 18-60 VDC shall also be available.
23. Ride through capability shall be available for backup control power for up to two (2) seconds, the rms values, as selected by the user.
24. The Circuit Monitor shall provide a hardware security switch to protect all revenue related metering configuration from unauthorized/accidental changes. The Circuit Monitor shall support the use of a wire seal to further deter inadvertent configuration changes and provide visual tamper indication.
25. The Circuit Monitor shall be a PowerLogic ION 7400 or PowerLogic Ion 9000T with small screen display as manufactured by Square D Company. Refer to Medium Voltage Switchgear specifications for meter locations.

B. Power Meters: For meters on 480V ATS's and meters not specified in MV Switchgear or LV Secondary Substation specifications, provide Square D PM5340 meters. Meters shall have Ethernet communication port.

1. Measured values

a. The Power Meter shall provide the following, true RMS metered quantities:

1) Real-Time Readings
2) Current (Per-Phase, N (calculated), 3-Phase Avg)
3) Voltage (L–L Per-Phase, L-L 3-Phase Avg, L–N Per-Phase, L-N 3-Phase Avg.)
4) Real Power (Per-Phase, 3-Phase Total)*
5) Reactive Power (Per-Phase, 3-Phase Total)*
6) Apparent Power (Per-Phase, 3-Phase Total)
7) Power Factor Signed (3-Phase Total)

8) Frequency
9) THD (Per-Phase, Current and Voltage)

b. Energy Readings

1) Accumulated Energy (Real kWh*, Reactive kVarh*, Apparent KVAh) (Absolute)

c. Demand Readings

1) Demand Current Calculations(Per-Phase):

a) Present
b) Peak

2) Demand Real Power Calculations(3-Phase Total):

a) Present
b) Peak

3) Demand Reactive Power Calculations(3-Phase Total):

a) Present
b) Peak

4) Demand Apparent Power Calculations(3-Phase Total):

a) Present
b) Peak

d. Power Analysis Values

1) THD - Voltage (Per-Phase, Line to Line, Line to Neutral
2) THD - Current (Per-Phase, Neutral)
3) Signed Power Factor (3-Phase)

e. Usage Time: The Power Meter should display the time that the device has been in service, displaying hours and minutes.

* kW, kVAR, kWh, and kVARh are signed net consumption values. The PM750 keeps a single registers with the net consumption values per each type of Energy and Power.

2. Demand: All power demand calculations shall use any one (1) of the following calculation methods, selectable by the user:

a. Block Interval Demand. The three following demand calculation modes shall be possible under Block Interval Demand: Sliding Block, Fixed Block, and Rolling Block.
b. Synchronized Demand
c. Thermal Demand

3. Sampling

a. The current and voltage signals shall be digitally sampled at a rate high enough to provide true rms accuracy to the 15th harmonic.
b. The Power Meter shall provide continuous sampling at a minimum of up to thirty two (32) samples/cycle, simultaneously on all voltage and current channels of the meter.

4. Minimum and Maximum Values

a. The Power Meter shall provide minimum and maximum values for the following parameters:

1) Voltage L-L
2) Voltage L-N
3) Current
4) Power Factor
5) Real Power Total
6) Reactive Power Total
7) Apparent Power Total
8) THD Voltage L-L
9) THD Voltage L-N
10) THD Current
11) Frequency

b. For each min/max value listed above, the Power Meter shall record the following attributes:

1) Min/Max. Value
2) Phase of recorded Min/Max (for multi-phase quantities)

c. Minimum and maximum values shall be available via communications and display.

5. Current Inputs

a. The Power Meter shall accept current inputs from standard instrument current transformers with 5 amp secondary output and shall have a metering range of 5mA-6 amps with the following withstand currents: 10 amp continuous, 50 amp 10 sec per hour, 120 amp 1 sec per hour.

b. Current transformer primaries adjustable from 5 - 32,767 A shall be supported.

6. Voltage Inputs

a. The circuit monitor shall allow connection to circuits up to 480 volts AC without the use of potential transformers. The Power Meter shall also accept voltage inputs from standard instrument potential transformers. The Power Meter shall support PT primaries through 1.6 MV.
b. The nominal full scale input of the Power Meter shall be 277 Volts AC L-N, 480 Volts AC L-L. The meter shall accept a metering over-range of 20%. The input impedance shall be greater than 2 Mohm (L-L) or 1 Mohm(L-N).

7. Accuracy

a. The Power Meter shall comply with IEC62053-22 Class 0.5S for Real Energy and IEC62053-23 Class 2 for Reactive Energy
b. Voltage shall be accurate to 03% from 50 to 227 V. Current shall be accurate to 0.4% from 1 to 6A. Power Factor shall be accurate from 1 to 6A. Power shall be accurate to 0.5%. Frequency metering shall be accurate to + 0.2 % from 45-65 Hz.
c. No annual calibration shall be required to maintain this accuracy.

8. Input/Output

a. The Power Meter shall include on-board two (2) Digital Inputs and One Digital Pulse Output. The Power Meter shall be capable of operating a solid state KY output relay to provide output pulses for a user definable increment of reported real energy. The standard KY output shall operate from 8–36 V DC max range, 24 V DC nominal. @ 25°C, 3.0 kV rms isolation, 28 Ω on-resistance @ 100 mA. It shall allow for the following operation modes:

1) External-This is the default setting. The output can be controlled by a command sent over the communications link.
2) Alarm-The output is controlled by the power meter in response to a Setpoint controlled alarm condition. When the alarm is active, the output will be ON. Multiple alarms can be associated with the same output simultaneously.
3) kWh Pulse-In this mode, the meter generates a fixed-duration pulse output that can be associated with the kWh consumption.

b. The Power Meter shall be capable of operating the two (2) Digital Inputs to provide all the following modes:

1) Normal-Use the normal mode for simple ON/OFF digital inputs.
2) Demand Interval Synch Pulse-Use this mode to configure a digital input to accept a demand synch pulse from a utility demand meter.
3) Digital Alarm-Use this mode to associate the input operation with any of the alarms. These alarms shall have a fixed pickup and dropout magnitude:
4) The two digital inputs shall operate from 12-36 V DC, 24 VDC nominal, impedance 12k Ohm, maximum frequency 25 Hz, response time 10 msec, and isolation 2.5kV rms

9. Upgrades

a. It shall be possible to field upgrade the firmware in the Power Meter to enhance functionality. These firmware upgrades shall be done through the communication connection and shall allow upgrades of individual meters or groups. No disassembly, changing of integrated circuit chips or kits shall be required and it will not be necessary to de-energize the circuit or the equipment to perform the upgrade.

10. Control Power

a. The Power Meter shall operate properly over a wide range of control power including 100-415 VAC, +/-10%, 5VA; 50 to 60Hz. Or 125-250 VDC, +/-20%, 3W.

11. Communications

a. The Power Meter shall communicate via RS-485 Modbus protocol with a 2-wire connection at speeds up to 19.2 kBaud.

12. Alarms: The Power Meter shall detect 15 predetermined alarms. All alarms shall be configured with the following values when using the display:

a. Enable-disable (default) or enable.
b. Pickup Magnitude
c. Pickup Time Delay
d. Dropout Magnitude
e. Dropout Time Delay
f. Values that can also be configured over communications are:
g. Alarm Type
h. Test Register
i. Alarm Label

13. Display

a. The Power Meter display shall be back lit LCD for easy viewing, display shall also be anti-glare and scratch resistant.
b. The Display shall be capable of allowing the user to view four values on one screen at the same time. A summary screen shall also be available to allow the user to view a snapshot of the system.
c. The Power Meter display shall provide local access to the following metered quantities:

    1) All quantities in Section B
    2) Minimum and Maximum readings in Section E
    3) Any of the Active Alarms from Section P
    4) I/O Status
d. Reset of the following electrical parameters shall also be allowed from the Power Meter display:

    1) Peak demand current
    2) Peak demand real power (kW) and peak reactive demand (kVAR).
    3) Energy (MWh) and reactive energy (MVARh)
e. Setup for system requirements shall be allowed from the Power Meter display. Setup provisions shall include:

    1) CT rating
    2) PT rating (Single Phase, 2-Wire)
    3) System type [three-phase, 3-wire] [three-phase, 4-wire]
    4) Watt-hours per pulse
    5) Communication parameters such as address and baud rate
    6) Alarms
    7) Digital I/O
    8) Demand calculation mode settings
    9) Bar graphs
    10) And Passwords for Setup and Reset]

## 2.6 ELECTRICAL METERING CABINET

A. The metering cabinet shall be appropriate for its environment but at a minimum UL type 1 listed steel enclosure with factory supplied knock-outs, or as specified on the drawings. The cabinet shall be approved for Type 1 and Type 3R applications. The enclosure shall have one set of incoming terminals for connecting the voltage metering leads.

B. Control power and voltage sensing power shall be separated for distribution to each meter from these main set incoming terminals.

C. External control power transformers shall not be needed for any power systems up to and including 480V.

D. Metering cabinet shall have fuse blocks for incoming voltage leads.

E. The enclosure shall have shorting terminal blocks for connecting the current transformer leads from the field to the meters. A factory wiring harness shall be provided to connect the CT circuit from shorting block to the meter.

F. The metering cabinet shall have terminal blocks for incoming and outgoing communications circuit connections.

2.7 LAN CABLES

A. Comply with Division 27 Section "Communications Horizontal Cabling."

B. RS-485 Cable:

1. Plenum-Type, RS-485 Cable: Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors, fluorinated-ethylene-propylene insulation, shielded, and fluorinated-ethylene-propylene jacket, and NFPA 70, Type CMP. Belden #8723 or approved equal.

C. Unshielded Twisted Pair Cables: Category 6 as specified for horizontal cable for data service in Division 27 Section "Communications Horizontal Cabling."

2.8 LOW-VOLTAGE WIRING

A. Comply with Division 26 Section "Control-Voltage Electrical Power Cables."

B. Low-Voltage Control Cable: Multiple conductor, color-coded, No. 20 AWG copper, minimum.

1. Sheath: PVC; except in plenum-type spaces, use sheath listed for plenums.
2. Ordinary Switching Circuits: Three conductors unless otherwise indicated.
3. Switching Circuits with Pilot Lights or Locator Feature: Five conductors unless otherwise indicated.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.2 INSTALLATION AND SOFTWARE INTEGRATION

A. All new electric meters added under this project including, but not limited to, the meters installed in Howard Hall, Bressler Research Building, the Peaking Plant, the North Switching Station, HSF1 and MSTF shall receive startup, programming, commissioning, and integration with the existing campus Power Monitoring Expert (PME) system.
   1. For the Peaking Plant meters, the electric meter shall also be programmed to include the totalized gas flow meter pulses and monitor the status from the gas booster pump.

B. Existing Peaking Plant Generator Meters: Under this project, the contractor shall include programming and integration of the two (2) existing ION 750 meters that are installed on the two existing generators at the peaking plant. The contractor shall integrate the meter into the existing Power Monitoring Expert (PME) system. This work shall also include the totalizez gas flow meter pulses from the generator fuel flow meters, the BGE gas meter pulses, and monitoring of the Gas Booster Pump common alarms.

## 3.3 INTEGRATION WITH BAS SYSTEM

A. Contractor shall provide communication with BAS system to provide information into the BAS system for the items listed below. The contractor shall include costs for inserting 10 points into the BAS sytem. The BAS system and metering system are on the same network.
   1. Distribution System on Generator (Howard Hall/BRB Generators and Peaking Plant Generators are running and supplying power to the North Switching Station)
   2. Common Alarms

## 3.4 CABLING

A. Comply with NECA 1.

B. Install cables and wiring according to requirements in Division 27 Section "Communications Horizontal Cabling."

C. Wiring Method: Install wiring in raceway and cable tray except within consoles, cabinets, desks, and counters. Conceal raceway and wiring except in unfinished spaces.

D. Install LAN cables using techniques, practices, and methods that are consistent with specified category rating of components and that ensure specified category performance of completed and linked signal paths, end to end.

E. Install cables without damaging conductors, shield, or jacket.

## 3.5 IDENTIFICATION

A. Identify components and power and control wiring according to Division 26 Section "Identification for Electrical Systems."

B. Label each power monitoring and control module with a unique designation.

## 3.6 GROUNDING

A. Comply with IEEE 1100, "Recommended Practice for Powering and Grounding Electronic Equipment."

## 3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Electrical Tests: Use caution when testing devices containing solid-state components.
2. Continuity tests of circuits.
3. Operational Tests: Set and operate controls at workstation and at monitored and controlled devices to demonstrate their functions and capabilities. Use a methodical sequence that cues and reproduces actual operating functions as recommended by manufacturer. Submit sequences for approval. Note response to each test command and operation. Note time intervals between initiation of alarm conditions and registration of alarms at central-processing workstation.

    a. Coordinate testing required by this Section with that required by Sections specifying equipment being monitored and controlled.
    b. Test LANs according to requirements in Division 27 Section "Communications Horizontal Cabling."
    c. System components with battery backup shall be operated on battery power for a period of not less than 10% of calculated battery operating time.
    d. Verify accuracy of graphic screens and icons.
    e. Metering Test: Load feeders, measure loads on feeder conductor with an rms reading clamp-on ammeter, and simultaneously read indicated current on the same phase at central-processing workstation. Record and compare values measured at the two locations. Resolve discrepancies greater than 5 percent and record resolution method and results.
    f. Record metered values, control settings, operations, cues, time intervals, and functional observations and submit test reports printed by workstation printer.

C. Power monitoring and control equipment will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

E. Correct deficiencies, make necessary adjustments, and retest. Verify that specified requirements are met.

F. Test Labeling: After satisfactory completion of tests and inspections, apply a label to tested components indicating test results, date, and responsible agency and representative.

G. Reports: Submit written reports of tests and observations. Record defective materials and workmanship and unsatisfactory test results. Record repairs and adjustments.

H. Remove and replace malfunctioning devices and circuits and retest as specified above and note corrective action in report.

## 3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train owner's maintenance personnel to adjust, operate, and maintain systems. See Division 01 Section "Demonstration and Training."

1. Train owner's management and maintenance personnel in interpreting and using monitoring displays and in configuring and using software and reports. Include troubleshooting, servicing, adjusting, and maintaining equipment. Provide a minimum of two (2) hours training.
2. Training Aid: Use approved final versions of software and maintenance manuals as training aids.

## 3.9 ON-SITE ASSISTANCE

A. Occupancy Adjustments: When requested within twenty four (24) months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other-than-normal occupancy hours for this purpose.

END OF SECTION 260913

# SECTION 260923 - LIGHTING CONTROL DEVICES

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 26.

### 1.2 SUMMARY

A. This Section includes the following lighting control devices:
   1. Outdoor and indoor photoelectric switches.
   2. Indoor occupancy sensors.
   3. Lighting contactors.

### 1.3 DEFINITIONS

A. LED: Light-emitting diode.

B. PIR: Passive infrared.

### 1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Show installation details for occupancy and light-level sensors.

   1. Interconnection diagrams showing field-installed wiring.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.

### 1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.6 COORDINATION

A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression system, and partition assemblies.

1.7 WARRANTY/GUARANTEE

A. See Division 26 Specification Section "Basic Electrical Requirements' for warranty and guarantee requirements.

**PART 2 - PRODUCTS**

2.1 OUTDOOR PHOTOELECTRIC SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the manufacturers specified:

1. Area Lighting Research, Inc.; Tyco Electronics.
2. Intermatic, Inc.
3. Paragon Electric Co.; Invensys Climate Controls.
4. TORK.
5. Watt Stopper (The).

B. Description: Solid state, with DPSTdry contacts rated for 1800-VA tungsten or 1000-VA inductive, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A.

1. Light-Level Monitoring Range: 1.5 to 10 fc, with an adjustment for turn-on and turn-off levels within that range, and a directional lens in front of photocell to prevent fixed light sources from causing turn-off.
2. Time Delay: 15-second minimum, to prevent false operation.
3. Surge Protection: Metal-oxide varistor, complying with IEEE C62.41.1, IEEE C62.41.2, and IEEE 62.45 for Category A1 locations.
4. Mounting: Twist lock complying with IEEE C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.

2.2 INDOOR OCCUPANCY SENSORS

A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the manufacturers specified:

1. Hubbell Lighting.
2. Leviton Mfg. Company Inc.
3. Lithonia Lighting; Acuity Lighting Group, Inc.
4. Novitas, Inc.
5. RAB Lighting, Inc.
6. Sensor Switch, Inc.
7. TORK.
8. Watt Stopper (The).

B. General Description: Wall- or ceiling-mounting mounted, solid-state units with a separate relay unit.

1. Operation: Unless otherwise indicated, turn lights on when covered area is occupied and off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of one (1) minute to fifteen (15) minutes.
2. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.
3. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, and Class 2 power source as defined by NFPA 70.
4. Mounting:

    a. Sensor: Suitable for mounting in any position on a standard outlet box.
    b. Relay: Externally mounted through a one half (1/2) inch knockout in a standard electrical enclosure.
    c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.

5. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.
6. Bypass Switch: Override the on function in case of sensor failure.
7. Automatic Light-Level Sensor: Adjustable from two (2) fc to two hundred (200) fc; keep lighting off when selected lighting level is present.

C. Dual-Technology Type: Ceiling mounting; detect occupancy by using a combination of PIR and ultrasonic detection methods in area of coverage. Particular technology or combination of technologies that controls on-off functions shall be selectable in the field by operating controls on unit.

1. Sensitivity Adjustment: Separate for each sensing technology.
2. Detector Sensitivity: Detect occurrences of six (6) inch minimum movement of any portion of a human body that presents a target of not less than thirty six (36) sq. in., and detect a person of average size and weight moving not less than twelve (12) inches in either a horizontal or a vertical manner at an approximate speed of twelve (12) inches.

3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of one thousand (1,000) sq. ft. when mounted on a ninety six (96) inch high ceiling.

## 2.3 LIGHTING CONTACTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the manufacturers specified:

1. ASCO Power Technologies, LP; a division of Emerson Electric Co.
2. Eaton Electrical Inc.; Cutler-Hammer Products.
3. Hubbell Lighting.
4. MicroLite Lighting Control Systems.
5. Square D; Schneider Electric.
6. TORK.
7. Touch-Plate, Inc.
8. Watt Stopper (The).

B. Description: Electrically operated and mechanically held, combination type with fusible switch complying with NEMA ICS 2 and UL 508.

1. Current Rating for Switching: Listing or rating consistent with type of load served, including LED driver for light fixtures.
2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
3. Enclosure: Comply with NEMA 250.
4. Provide with control and pilot devices as indicated on Drawings, matching the NEMA type specified for the enclosure.

C. BAS Interface: Provide hardware interface to enable the BAS to monitor and control lighting contactors.

1. Monitoring: On-off status.
2. Control: On-off operation.

## 2.4 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

## PART 3 - EXECUTION

### 3.1 SENSOR INSTALLATION

A. Install and aim sensors in locations to achieve not less than 90% coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

### 3.2 CONTACTOR INSTALLATION

A. Mount electrically held lighting contactors with elastomeric isolator pads, to eliminate structure-borne vibration, unless contactors are installed in an enclosure with factory-installed vibration isolators.

### 3.3 WIRING INSTALLATION

A. Wiring Method: Comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size shall be.

B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

C. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.

D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

### 3.4 IDENTIFICATION

A. Identify components and power and control wiring according to Division 26 Section "Identification for Electrical Systems."

1. Identify controlled circuits in lighting contactors.
2. Identify circuits or luminaries controlled by photoelectric and occupancy sensors at each sensor.

B. Label time switches and contactors with a unique designation.

## 3.5 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. After installing time switches and sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.
2. Operational Test: Verify operation of each lighting control device, and adjust time delays.

B. Lighting control devices that fail tests and inspections are defective work.

## 3.6 ADJUSTING

A. Occupancy Adjustments: When requested within twelve (12) months of date of Substantial Completion, provide on-site assistance in adjusting sensors to suit occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

END OF SECTION 260923

# SECTION 261116 - SECONDARY UNIT SUBSTATIONS

## PART 1 - GENERAL

### 1.1 RELATED DOCOMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 26.

### 1.2 SUMMARY

A. This Section includes indoor and outdoor secondary unit substations, each consisting of the following:

1. Primary incoming section.
2. Transformer.
3. Secondary distribution section.

### 1.3 DEFINITIONS

A. NETA ATS: Acceptance Testing Specification.

### 1.4 SUBMITTALS

A. Compliance Statement as described under the quality assurance section of this specification.

B. Product Data: Include rated capacities, furnished specialties, and accessories.

C. 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.

1. Wiring Diagrams: Power, signal, and control wiring.
2. Dimensioned plans and elevations showing major components and features including working clearances, conduit entry points, and base mounting points.
3. One-line diagram.
4. List of materials.
5. Nameplate legends.
6. Size and number of bus bars and current rating for each bus, including mains and branches of phase, neutral, and ground buses.

7. Short-time and short-circuit current ratings of secondary unit substations and components.
8. Ratings of individual protective devices.
9. Transformer section submittals (where transformer is specified) including:
    a. Dimensioned plan and elevations with tap, control power transformer, fan and temperature monitor locations, and phase, neutral and ground connection locations.
    b. Enclosure details, including removable panel descriptions, louver locations, control wiring routing, sheet metal gauge, and painting details.
    c. Terminal locations and details for phase, neutral and ground connections.
    d. Coil conductor materials and construction.
    e. Insulation materials.
    f. Test data sheets for similar transformers with test data on load losses, no-load losses and sound level.
    g. Temperature control system description, including details on the control power transformer, fans, temperature monitor, alarms and hinged panel for the monitor.
    h. Schematic and connection diagrams for the temperature control system.
    i. Full size copy of the nameplate.
    j. Coil-to-bus/line connection materials, support and details.
    k. Bus bar and line termination connection and support details.
    l. ANSI Damage curve for secondary unit substation transformers.
    m. Detailed location, mounting and wiring of the lightning arrestors.
    n. Primary Fuses: Submit recommendations and size calculations.
10. Secondary voltage distribution section submittals containing:
    a. Dimensioned plan and elevations with circuit breaker, current sensor and metering device locations, and phase, neutral and ground bus terminal locations.
    b. One line diagram with bus, circuit breaker, trip unit, metering device and fuse quantities and ratings, and interlock provisions.
    c. Compartment details including front door and rear panel descriptions, sheet metal gauge, painting details, mimic bus details, and breaker lifting device description.
    d. Terminal locations and details for phase, neutral and ground connections.
    e. Phase-to-phase clearances and phase-to-ground clearances.
    f. Bus bar connection and support details and bus materials.
    g. Insulator and barrier details and materials.
    h. Circuit breaker, trip unit, and current sensor descriptions.
    i. Trip unit time-current characteristic curves.
    j. Detailed circuit breaker controls details, schematic and connection diagrams, and sequences of operation including terminal point numbers and locations
    k. Secondary metering description, including details on the current transformers, potential transformers, ammeters, voltmeters, and meter switches.

l. Schematic and connection diagrams for the secondary metering systems.
m. Schematic and connection diagrams for the PLC system including terminal point numbers and locations
n. DC Connection schematics including terminal point numbers and locations
o. Nameplate engraving.
p. Time-current curves, including selectable ranges for each type of overcurrent protective device.
q. Mimic-bus diagram.

D. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Dimensioned concrete base, outline of secondary unit substation, conduit entries, and ground rod locations.
2. Location of structural supports for structure-supported raceways and busways.
3. Location of lighting fixtures, sprinkler piping and heads, ducts, and diffusers.

E. Product Certificates: For secondary unit substations, signed by product manufacturer.

F. Qualification Data: For independent testing agency.

G. Material Test Reports: For secondary unit substations.

H. Factory test reports.

I. Field quality-control test reports.

J. Operation and Maintenance Data: For secondary unit substations and accessories to include in emergency, operation, and maintenance manuals.

## 1.5 QUALITY ASSURANCE

A. Compliance Statement: The equipment manufacturer shall include a Compliance Statement, at the time of Bid, listing each Specification Section, and Part 1, 2, and 3 Sub-Sections, stating, paragraph-by-paragraph, compliance with the Specification, each minor nonconformity that is within the intent of the Specification, and proposed nonconformities. Provide short description of minor nonconformities, and detailed explanation of other nonconformities.

B. Independent Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

C. Source Limitations: Obtain secondary unit substation through one source from a single manufacturer.

D. Product Options: Drawings indicate size, profiles, and dimensional requirements of secondary unit substations and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

E. Electrical Components, Devices and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

F. Comply with IEEE C2.

G. Comply with IEEE C37.121.

H. Comply with NFPA 70.

## 1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver in shipping splits in sizes that can be moved past obstructions in delivery path.

B. Coordinate delivery of secondary unit substations to allow movement into designated space.

C. Store secondary unit substation components protected from weather and so condensation will not form on or in units. Provide temporary heating according to manufacturer's written instructions.

D. Handle secondary unit substation components according to manufacturer's written instructions. Use factory-installed lifting provisions.

## 1.7 PROJECT CONDITIONS

A. Field Measurements: Indicate measurements on Shop Drawings.

B. Interruption of Existing electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify UM no fewer than 10 days in advance of proposed interruption of electric service.
2. Do not proceed with interruption of electric service without UM's written permission.
3. Outages to existing loads shall occur during off hours.

    a. If contractor elects to do outages or switchovers during normal hours then contractor shall submit a plan to be approved by the owner and provide temporary power at no additional cost.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchgear, including clearances between switchgear, and adjacent surfaces and other items. The Equipment Manufacturer shall fabricate the equipment to within indicated maximum dimensions with clearances to accommodate access for maintenance and operation.

## 1.8 COORDINATION

A. Coordinate layout and installation of secondary unit substations with other construction that penetrates floors and ceilings, or is supported by them, including light fixtures, HVAC equipment, and fire-suppression-system components.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

## 1.9 EXTRA MATERIALS

A. Furnish extra materials described below, before installation begins, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Spare fuses: 10% of total for project; each type and rating of fuse and fusible device used, except for medium-voltage fuses. Include spares for the following:

    a. Primary disconnect fuses.
    b. Potential transformer fuses.
    c. Control power fuses.
    d. Fuses and fusible devices for fused circuit breakers.
    e. Fuses for secondary fusible devices.

2. Spare Indicating Lights: Six of each type installed.
3. Touchup Paint: One half-pint container of paint matching enclosure's exterior finish.
4. Primary Switch Contact Lubricant: One container.

5. One set of spare mounting gaskets for bushings, handholes, and the gasket between relief cover and flange of pressure relief device

1.10 WARRANTY/GUARANTEE

A. See Division 26 Specification Section “Basic Electrical Requirements’ for warranty and guarantee requirements.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. ABB Control, Inc.
2. Eaton
3. Siemens
4. Square D; Schneider Electric.

2.2 MANUFACTURED UNITS

A. Indoor Unit Arrangement: As shown on drawings.

B. Enclosure Finish: Factory-applied finish in manufacturer's standard color, including under surfaces treated with corrosion-resistant undercoating.

2.3 INCOMING SECTION

1. Primary Incoming Section. As indicated on the drawings provide one of the following: Terminal assembly with adequate space for incoming cable terminations and surge arresters, complying with NEMA SG 4 and meeting thermal, mechanical, and dielectric requirements specified for the transformer section.

2. Enclosed, air-interrupter, dual primary switch.
   a. Three pole, single throw, dead front, metal enclosed, with manual stored energy operator, frame complying with IEEE C37.20.3.
   b. Key interlocking system to prevent fuse access door from being opened unless switch is open
   c. Allow non-interlock operation of dual primary switches.
   d. Phase Barriers: Located between blades and fuses of each phase, designed for easy removal, allows visual inspection of switch components when barrier is in place.

e. IR Port: 3 inches.
f. Window: Permits viewing switch-blade positions when door is closed.
g. Accessory Set: Tools and miscellaneous items required for interrupter switchgear test, inspection, maintenance, and operation. Include fuse-handling tool as recommended by switchgear manufacturer.
h. Continuous-Current Rating: 600 A.
   1) Short-Circuit Rating:
   2) Short-time momentary asymmetrical fault rating of 40 kA.
   3) 2-second symmetrical rating of 25-kA RMS.
   4) Fault close asymmetrical rating of 40 kA.
i. Fuses: Sizes recommended by secondary unit substation manufacturer, considering fan cooling, temperature-rise specification, and cycle loading. Comply with the following:
   1) Current-limiting type, rated for not less than 50-kA RMS symmetrical current-interrupting capacity.
   2) Indicator integral with each fuse to show when it has blown.
   3) Spares: Include three fuses in use and three spare fuses in storage clips in each switch.

B. Surge Arresters: Comply with IEEE C62.11, Distribution class; metal-oxide-varistor type, with ratings as indicated, connected in each phase of incoming circuit and ahead of any disconnecting device. Comply with IEEE.

## 2.4 DRY-TYPE TRANSFORMER SECTION

A. Description: As indicated on the drawings provide:

IEEE C57.12.01,IEEE C57.12.51, NEMA ST 20, and dry-type, 2-winding, secondary unit substation transformer.

B. Enclosure: Indoor, ventilated, vacuum-pressure impregnated type, with insulation system rated at $185^0$C with an $80^0$C average winding temperature rise above a maximum ambient temperature of $40^0$ C.

C. Cooling System: Class AA/FA, air cooled with forced-air rating complying with IEEE C57.12.01.
   1. Automatic forced-air cooling system controls, including thermal sensors, fans, control wiring, temperature controller with test switch, power panel with current-limiting fuses, indicating lights, alarm, and alarm silencing relay.
   2. The temperature controller shall be mounted flush on the front of the transformer, 54 inches above finished floor.
   3. The temperature monitor shall be mounted on a hinged front plate of a flush mounted box. The electrical connection shall be accessible and the monitor shall be removable without de-energizing the transformer.
   4. The wiring for the temperature monitor shall be routed and supported independently of the transformer enclosure so that the enclosure panels can be

removed without affecting the wiring. All wiring shall comply with the requirements of the Control Wiring section of this specification.

5. The temperature monitor shall include an LED or LCD display to allow reading of the hot spot temperature in each phase, and the highest temperature seen on each phase since the last reset. Additional features as listed below:
6. A reset button shall be provided to reset the maximum readings.
7. Indication Lights:
8. Green – Power On
9. Amber – Fan On
10. Red – High Temperature
11. Alarm Silence Pushbutton
12. Auto/Manual Fan Control Switch
13. System Test Switch

D. Insulation Materials: IEEE C57.12.01, rated $220^0$C.

E. Insulation Temperature Rise: $80^0$C, maximum rise above $40^0$C.

F. Basic Impulse Level: 95 kV.

G. Full-Capacity Voltage Taps: 4 nominal 2.5% taps, 2 above and two (2) below rated primary voltage.

H. Sound level may not exceed 64dBA level, without fans operating.

I. Impedance: 5.75 percent.

J. Transient Resistant Design: For transformers switched by vacuum circuit breakers and/or not closed coupled to a fused switch, transformers shall be provided with an RC Snubber to resist transients induced by the vacuum circuit breaker switching.

K. High-Temperature Alarm: Sensor at transformer with local audible and visual alarm and contacts for remote alarm. Provide Square D Model 98 transformer temperature monitor for remote recording of transformer winding temperatures.

L. Core and Coil Assemblies: Transformer coils shall be copper continuously wound on a non-aging, cold-rolled, grain-oriented, high permeability silicon metal core of electrical grade steel with insulated laminations. Aluminum windings are not acceptable.

M. Core and coil assembly shall be mounted on a structural steel base, which shall be isolated from the rest of the structure by vibration pads.

N. The electrical insulation system shall utilize Class H material in a fully rated 220 degree C system. Transformer design temperature rise shall be based on a 30 degrees C average ambient over a 24-hour period with a maximum of 40 degrees C. Solid insulation in the transformer shall consist of inorganic materials such as porcelain, glass fiber, electrical grade glass polyester or Nomex. All insulating materials must be rated for continuous 220

degree C duty. The insulation between the high and low voltage coils shall be more than sufficient for the voltage stress without the need of a varnish.

O. High-voltage and low-voltage windings shall be copper. The high voltage winding shall be wound over the low voltage winding with sufficient mechanical bracing to prevent movement during fault conditions and sufficient solid insulation to isolate the high voltage winding dielectric potential from the low voltage windings.

P. Sound level may not exceed sound levels listed in NEMA TR 1, without fans operating.

## 2.5 SECONDARY DISTRIBUTION SECTION

A. North Switching Station Secondary Distribution: Low-voltage switchboard as specified in Division 26 Section "Switchboards."

B. For Howard Hall, Bressler Research Buidling, and HSF1 Generator Switchgear, the secondary distribution section shall be drawout, low-voltage switchgear, complying with IEEE C37.20.1 and UL 1558.
   1. Section barriers between all circuit-breaker compartments shall be extended to rear of section.

C. Switchgear Structure:
   1. Match and align the front and back of the switchgear.
   2. Isolate line bus from load bus at each main and tie circuit breaker with bus isolation barriers.
   3. Allow the following circuit-breaker functions to be performed when the compartment door is closed:

      a. Operate manual charging system.
      b. Open and close the circuit breaker.
      c. Examine and adjust the trip unit.
      d. Read the breaker nameplate.

   4. Locate instrumentation transformers within the breaker cell, and make front accessible and removable.
   5. The sections shall be constructed of steel frames and heavy gauge steel panels sized to maintain required alignments and clearances at all times. The sections shall also be sufficiently rigid to restrict deformation from external forces and weights that may be applied during maintenance activities.
   6. The sections shall be capable of withstanding the lifting, skidding, jacking and/or rolling (in any direction) actions needed to install the equipment. Factory installed lifting eyes shall be provided on each section.
   7. The sections shall have provisions for anchoring to channel embeds in the housekeeping pad.

8. Section barriers between all circuit-breaker compartments shall be extended to rear of section.
9. Bus isolation barriers shall be arranged to isolate line bus from load bus at each main and tie circuit breaker.
10. Circuit-breaker compartments shall be equipped to house drawout-type circuit breakers and shall be fitted with hinged outer doors.

D. Switchgear Bus:
1. Use bus bars to connect compartments and vertical sections. Cable connections are not permitted.
2. Main Phase Bus: Uniform capacity the entire length of section.
3. Vertical Section Bus Size: Comply with IEEE C37.20.1, including allowance for spare circuit breakers and spaces for future circuit breakers.
4. Phase-Bus Material: Hard-drawn copper of 98 percent minimum conductivity, with copper feeder circuit-breaker line connections.
5. Use copper for connecting circuit-breaker line to copper bus.
6. Contact Surfaces of Buses: Silver plated.
7. Feeder Circuit-Breaker Load Terminals: Insulated silver-plated copper bus extensions equipped with bolted connectors for outgoing circuit conductors. Provide cable lugs sized as indicated on the drawings.
8. Ground Bus: Hard-drawn copper of 98 percent minimum conductivity, with pressure connector for feeder and branch-circuit ground conductors, minimum size 1/4-by-2 inches (6 by 50 mm).
9. Provide for future extensions from either end of main phase, neutral, and ground bus by means of predrilled bolt-holes and connecting links.
10. Bus-Bar Insulation: Individual bus bars wrapped with factory-applied, spray-applied, flame-retardant insulation.

    a. Sprayed Insulation Thickness: 3 mils (0.08 mm), minimum.
    b. Bolted Bus Joints: Insulate with secure joint covers that can easily be removed and reinstalled.

11. Supports and Bracing for Buses: Adequate strength for indicated short-circuit currents, 65kA.
12. The vertical bus shall be held rigid in a support structure of non-hygroscopic and flame retardant molded glass reinforced polyester.
13. Vertical and horizontal busbars shall be isolated from the cable compartment by steel barriers. No live busbars shall be accessible from the rear cable compartments except the circuit breaker load side terminations.
14. Cable feeder compartments shall have sufficient space for all cables entering from above and shall be easily accessible from the rear. Cable tie points shall be provided on the sides of such sections. No cable tie bars shall block access to the rear of the switchgear.

E. Special Provisions to Accommodate Switchgear Maintenance:

1. Barriers covering the bus sub-assembly in each section of gear shall be designed for ease of removal to accommodate maintenance.
2. Where carriage bolt assemblies are installed at bus connections, the bolts shall face the rear of the switchgear to facilitate access for maintenance.
3. The switchgear shall be arranged to allow thermal and ultrasonic scans with the bus energized and under load.

    a. Provide two (2) combined visual, Ultraviolet (UV), and Infrared (IR), rectangular viewing windows in the rear cover of each switchgear section. Center each window at 1/3 points along the height of the section and centered horizontally on the section so that all cable terminations can be scanned through the windows.
    b. Provide one (1) round ultrasonic scan window in the front door of each breaker compartment. Locate the window so that a scan can be made of the arc chutes and contacts of the breaker.

4. Provide design details to the Government's Representative prior to manufacturer to confirm compliance with the above provisions.

F. Circuit Breaker Compartment:
1. Drawout Features: Circuit-breaker mounting assembly equipped with a racking mechanism to position circuit breaker and hold it rigidly in "connected," "test," and "disconnected" positions. Include the following features:

    a. Interlocks: Prevent movement of circuit breaker to or from "connected" position when it is closed, and prevent closure of circuit breaker unless it is in "connected," "test," or "disconnected" position.
    b. Circuit-Breaker Positioning: Permit the racking of an open circuit breaker to or from "connected," "test," and "disconnected" positions only when the compartment door is closed unless live parts are covered by a full dead-front shield. Permit the manual withdrawal of an open circuit breaker to a position for removal from the structure. When the compartment door is open, status for connection devices for different positions includes the following:

        1) Test Position: Primary disconnects disengaged, and secondary disconnect devices and ground contact engaged.
        2) Disconnected Position: Primary and secondary devices and ground contact disengaged.

2. Primary Disconnect: Mount on the stationary part of the compartment. The disconnect shall consist of a set of contacts extending to the rear through an insulating support barrier, and of corresponding moving finger contacts on the power circuit-breaker studs, which engage in only the "connected" position. The assembly shall provide multiple silver-to-silver full floating, spring-loaded, high-pressure-point contacts with uniform pressure on each finger. Load studs shall

connect to bus extensions that terminate in solderless terminals in the rear cable compartment.

3. Secondary Disconnect: Floating terminals mounted on the stationary part of the compartment that engage mating contacts at the front of the breaker. Disconnecting devices shall be gold plated, and engagement shall be maintained in the "connected" and "test" positions.
4. Each compartment shall be dead-front. Shutters shall close automatically as a breaker is racked out of the “connected” position. Control contacts shall be “made” when the breaker is in the “test” or “connected” position.
5. A guide rail system shall be used to ensure accurate alignment of the breaker primary and secondary disconnects during drawout operation.
6. Positive mechanical interlocks shall prevent the circuit breaker from being racked in or out unless the circuit breaker is open, and shall prevent the circuit breaker from being closed while it is being racked in or out. The circuit breaker shall not be permitted to close except in the “connected” and “test” positions.
7. Each circuit breaker cubicle shall contain a positive rejection mechanism so that only the circuit breaker frame for which the cubicle was designed can be inserted.
8. Anti-pumping mechanism shall be provided.
9. Compartment doors shall have padlocking hasps.
10. Circuit breakers shall be capable of being padlocked in the drawn-out position.
11. Main, Tie, and Feeder Circuit Breaker Compartments: Shutters shall be supplied to cover circuit breaker primary line and load disconnects when the circuit breaker carriage is removed from its compartment.

G. Circuit Breakers:
1. Circuit breakers shall be individually mounted, drawout, 600 volt (nominal) power circuit breakers in compliance with ANSI C37.13, C37.16, C37.17, C37.50, NRTL-listed and labeled to UL-1066.
2. Ratings: For continuous, interrupting, and short-time current ratings for each circuit breaker as indicated on the drawings; voltage and frequency ratings same as switchgear.
3. Operating Mechanism: Mechanically and electrically trip-free, stored-energy operating mechanism with the following features:

    a. Normal Closing Speed: Independent of both control and operator.
    b. Slow Closing Speed: Optional with operator for inspection and adjustment.
    c. Stored-Energy Mechanism: Electrically charged, and .the operator's choice of manual charging.

        1) Operating Handle: One for each circuit breaker capable of manual operation.
        2) Electric Close Button: One for each electrically operated circuit breaker. This control switch shall be a Series 31-B knob.
        3) All open and close buttons on the circuit breakers shall be equipped with a protective cover to prevent inadvertent operation.

d. Operation counter.

4. Trip Devices: Solid-state, overcurrent trip-device system consisting of one or two current transformers or sensors per phase, a release mechanism, and the following features:

   a. Provide trip devices which are interchangeable between compatible breaker frames. Interchangeable rating plugs shall establish the continuous trip ratings of each circuit breaker. The rating plug shall be interlocked with the tripping mechanism to automatically "open" the breaker when the plug is removed. The breaker shall remain "trip free" with the plug removed. In addition, rating plugs shall be keyed to prevent incorrect application between different frame ratings.
   b. Functions: Long-time-delay, short-time-delay, and instantaneous-trip functions, independent of each other in both action and adjustment.
   c. Temperature compensation that ensures accuracy and calibration stability from minus 5 to plus 40 deg C. Circuit breakers shall have short circuit current withstands and interrupting ratings that meet or exceed 65kA symmetrical fault current.
   d. Field-adjustable, time-current characteristics.
   e. Current Adjustability: Dial settings and rating plugs on trip units, or sensors on circuit breakers, or a combination of these methods.
   f. Three bands, minimum, for long-time- and short-time-delay functions; marked "minimum," "intermediate," and "maximum."
   g. Pickup Points:

      1) Five minimum, for long-time- and short-time-trip functions. Equip short-time-trip function for switchable I-squared-t operation.
      2) Five minimum, for instantaneous-trip functions.

   h. Ground-fault protection with at least three short-time-delay settings and three trip-time-delay bands; adjustable current pickup.

      1) Arrange to provide protection for three-wire circuit or system.
      2) Arrange to provide protection for four-wire circuit or system.
      3) Arrange to provide protection for four-wire, double-ended substation.

5. The trip units shall utilize a Maintenance mode that shall reduce the trip unit Instantaneous pickup value when activated. The device shall not compromise breaker phase protection even when enabled. When Maintenance Mode is disabled, recalibration of the trip unit phase protection shall not be required. Activation and de-activation of the Maintenance Mode trip setting shall be accomplished without opening the circuit breaker door and exposing operators to energized parts. The Maintenance Mode trip settings shall be adjustable with a minimum of five settings ranging from 2.5X to 10X of the sensor value. The

ARMs shall be provided with a blue panel mounted selector switch with integral indication via a blue LED pilot light.

6. All trip units shall be provided with zone selective interlocking schemes.
7. Trip Indication: Labeled, battery-powered lights or mechanical targets on trip device to indicate type of fault.
8. Auxiliary Contacts:

    a. Contacts and switches required for normal circuit-breaker operation, sufficient for interlocking and remote indication of circuit-breaker position.
    b. Spare auxiliary switches, at least two, unless other quantity is indicated. Each switch shall consist of two Type A and two Type B contacts wired through secondary disconnect devices to a terminal block in stationary circuit-breaker compartment.

9. Arc Chutes: Readily removable from associated circuit breaker when it is in "disconnected" position, and arranged to permit inspection of contacts without removing circuit breaker from switchgear.
10. Padlocking Provisions: For installing at least three padlocks on each circuit breaker to secure its enclosure and prevent movement of drawout mechanism.
11. Circuit breakers shall contain a true two-step, stored energy mechanism providing quick-make, quick-break operation capable of charging-after-close operation. It shall be possible to discharge the closing springs without closing the main contacts. Maximum closing time shall be 5 cycles at nominal control voltage.
12. The tie breaker shall be identical to the main breakers and shall be capable of being exchanged with either main breaker.
13. A factory-installed "OFF" button padlock provision shall be included to prevent charging of the breaker mechanism when it is engaged.
14. Movement of the breaker handle alone shall not cause the breaker to change state (open or close).

H. Mechanical Interlocking of Circuit Breakers: Uses a mechanical tripping lever or equivalent design and electrical interlocks.

I. Key Interlocks: Arranged to prevent opening or closing interlocked circuit breakers, except in a specified sequence. Include mountings and hardware for future installation of key interlocks.

J. Sync Check Relays: Provide sync check relays on Main and Tie breakers to allow closing of breakers when both sides of breakers are synchronized or when closing into a dead bus. Sync check relays will also allow for closed transition transfer of sources.

K. PLC Interlock: Provide programming through PLC to prevent both main breakers and tei breaker being closed if the Howard Hall 15kV switchgear is being fed from two different BGE substations (one side from the north switching station and one side fed from the south switching station).

L. Local/Remote Switch: Provide a Local/Remote Switch on the switchgear. The Local/Remote switches shall prevent any remote control (automated or manually initiated from HMI) of the switchgear from the control system when in "Local". When Local/Remote switch is in "Local" the HMI shall display an alarm. Switch shall be pad-lockable. The Local/Remote switch shall be located on the switchgear for each specific bus. Provide Local/Remote Switches for the following:
   1. Howard Hall 480V Switchgear (One L/R Switch for both buses)
   2. Bressler Research Building 480V Switchgear (One L/R Switch for both buses)

M. Control Power:
   1. Manual spring charging operators and close and trip pushbuttons shall be accessible from the front of the circuit breaker when it is installed in a cubicle, with the cubicle door closed.
   2. The following circuit breaker operating status mechanical indicators at the front door of each circuit breaker compartment:

      a. Closing spring status (charged/discharged).
      b. Circuit breaker main contact status (open/closed).
      c. Circuit breaker drawout position (connect/test/disconnect).

   3. Standard padlocking provisions, on the front of the circuit breaker, to lock the circuit breaker open and mechanically trip-free. The padlock provision shall accept up to three padlocks with 1/4 to 3/8 inch diameter shank.
   4. Provide circuit breaker mechanism operated contacts (MOC) and truck operated contacts (TOC) as required for implementation of the specified control logic.
   5. Provide two spare sets of contacts that open when the circuit breaker is open and close when the circuit breaker closes (52a), and two spare sets of contacts that close when the circuit breaker is open and open when the circuit breaker closes (52b), wired through secondary disconnect devices to a terminal block in the stationary housing. Provide an auxiliary relay to provide additional "52a" and "52b" contacts for each breaker. Provide the maximum number of contacts allowable for each type.
   6. Circuit breakers shall be equipped with wheels that allow the circuit breaker to be rolled into the cubicle once it is installed on the drawout rails.

N. Undervoltage Trip Devices: Instantaneous, with adjustable pickup voltage and adjustable time delay.

O. Indicating Lights: To indicate circuit breaker is open or closed, for main and bus tie circuit breakers interlocked either with each other or with external devices. All indicating lights shall be LED type with push-to-test feature.
   1. Red – Closed
   2. Green – Open
   3. Amber/Blue/White – General Indication as required for interlocking.

## 2.6 LOW VOLTAGE INSTRUMENT SECTION

A. Instrument Transformers: Comply with IEEE C57.13.
   1. Potential Transformers: Secondary-voltage rating of 120 V and NEMA accuracy class of 0.3 with burdens of W, X, and Y shall be provided on the bus side of the main breaker.
   2. Metering Current Transformers: Ratios as required for the application, burden, and accuracy class suitable for connected meters and instruments.
   3. Protection Current Transformers: Integral to circuit breaker rating plug assembly. Rating plugs shall be removable for increasing/decreasing trip unit rating without removing or replacing the trip unit itself.

B. Multifunction Digital-Metering Monitor: Provide Square-D PM5340 on 480V Main Breakers.
   1. Provide CT Shorting blocks located within the switchgear.

C. Control Wiring: Factory installed type SIS rated 600 volt, 90 degrees C, furnished with wire markers at each termination except where installation environments (temperature and chemical) require specialized insulation systems. Wires shall terminate on terminal blocks with marker strips numbered in agreement with detailed connection diagrams complete with bundling, lacing, and protection. Complying with the following:
   1. Flexible stranded conductors for No. 12 AWG and larger.
   2. Minimum size of #14 AWG for 120VAC circuits, minimum size of #12 AWG for 125VDC circuits.
   3. All current transformer circuits shall be #10 AWG and wired through shorting type terminal blocks.
   4. All control wiring shall be 600V SIS. The use of nylon or PVC jackets is not acceptable.
   5. Each control wire shall be uniquely numbered at each end and at each termination point.
   6. No more than two wires shall be connected at a single wiring terminal. Thread on wire nuts or split bolt connectors are not permitted. In-line control wire splices are not acceptable.
   7. Terminal block shall be provided for all conductors requiring connection to circuits external to the specified equipment, where internal circuits cross shipping splits, and where equipment part replacement and maintenance will be facilitated.
   8. Leave slack in bundled conductors at hinges and interconnections between shipping units. Wiring traversing hinges or other forms of flexible constructions shall be high stranded and shall traverse the area of bending normal to the plane of rotation so as to impart a twisting rather than a bending motion to the cable or wire bundle.
   9. Short circuiting type terminal blocks shall be provided for shorting and grounding all CT leads. Non-short circuiting type terminal blocks shall be provided for terminating all control and protection leads.

10. All control wiring shall be routed through the low voltage compartments and secured using tie wraps.

## 2.7 PROGRAMMABLE LOGIC CONTROLLER (PLC)

A. Refer to 262313 Switchgear Controls and Automation Specification. Control system for 480V substations shall be fully integrated with Medium Voltage control system.

## 2.8 GRAPHIC TOUCHSCREEN INTERFACE PANEL (HMI)

A. Refer to 262313 Switchgear Controls and Automation Specification. Control system for 480V substations shall be fully integrated with Medium Voltage control system.

## 2.9 ACCESSORIES

A. Maintenance Tools: Furnish tools and miscellaneous items required for circuit-breaker and switchgear test, inspection, maintenance, and operation.
   1. Racking handle to manually move circuit breaker between "connected" and "disconnected" positions. (Total of 4 per unit substation)
   2. Portable test set for testing all functions of circuit-breaker, solid-state trip devices without removal from switchgear.
   3. Relay and meter test plugs suitable for testing switchgear meters and switchgear class relays.
   4. Circuit-Breaker Removal Apparatus: Overhead-circuit-breaker lifting device, track mounted at top front of switchgear and complete with hoist and lifting yokes matching each size of drawout circuit breaker installed.
   5. Remote Racking Device: Remote racking device capable of remotely inserting or removing the drawout circuit breakers while the operator is away from the switchgear. Device should operate off 120V receptacle.

B. Combination visual, UV, and IR scan windows shall be rectangular having an overall outside dimension of 12”W x 8.1”H with a window dimension of 9.3”W x 5”H. Window housing shall be aluminum with a locking cover and 316 stainless steel hardware. Optical material shall be a UL 746 compliant visual, UV, and IR transmissive polymer. Window shall be rated IP65/NEMA 4. Window shall be IRISS CAP-CT-12.

C. Ultrasound ports shall be round with a body diameter of 2.6” with a port diameter of 0.5”. Ports shall be made of UL 94 5VA nylon with a stainless steel cover. Ports shall be rated IP65/NEMA 4 when closed. Ports shall be IRISS VP-12-US.

## 2.10 IDENTIFICATION DEVICES

A. Compartment Nameplates: Engraved, laminated-plastic or metal nameplate for each compartment, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section "Identification for Electrical Systems."

## 2.11 SOURCE QUALITY CONTROL

A. Factory Tests: Perform design and routine tests according to standards specified for components. Conduct transformer tests according to IEEE C57.12.90. Conduct switchgear and switchboard tests according to ANSI C37.51.
   1. The PLC programmer shall be available and present at the factory site during the full factory witness testing period so that any discovered issues or necessary modifications may be addressed at that time. The same PLC programmer shall be available during the complete site start-up and testing effort (see Part 3) and shall be present during the full site witness testing period so that any discovered issues or necessary modifications may be addressed at that time.
   2. Submit all test procedures for approval and notify the Project Manager thirty days prior to commencement of any tests. Testing shall be witnessed by the Owner, and/or their duly authorized representatives. Indicate the approximate duration of the tests.
   3. Provide four (4) copies of the factory test reports within two weeks of the completion of factory testing detailed herein.

B. Factory Tests: Perform the following factory-certified tests on each secondary unit substation:
   1. Transformer Tests (Where Transformer is Provided):
      a. Resistance measurements of all windings on the rated voltage connection and on tap extreme connections.
      b. Ratios on the rated voltage connection and on tap extreme connections.
      c. Polarity and phase relation on the rated voltage connection.
      d. No-load loss at rated voltage on the rated voltage connection.
      e. Exciting current at rated voltage on the rated voltage connection.
      f. Impedance and load loss at rated current on the rated voltage connection and on tap extreme connections.
      g. Applied potential.
      h. Induced potential.
      i. Temperature test is not required if a record of a temperature test on an essentially duplicate unit is available.
   2. Switchgear Tests:
      a. The switchgear shall be completely assembled, wired, adjusted and tested at the factory.

b. After assembly, the complete switchgear shall be tested to ensure the accuracy of the wiring and the functioning of all equipment.
c. The main bus system shall be given a dielectric test of 2200 volts for one minute between live parts and ground and between opposite polarities.
d. The wiring and control circuits shall be given a dielectric test of 1500 volts for one minute, or 1800 volts for one second, between live parts and ground, in accordance with ANSI C37.20.1.
e. Completely demonstrate the special provisions to accommodate switchgear maintenance.
f. A certified test report of all standard production tests shall be shipped with each assembly.
g. Verify mechanical operation; interlocks and interchangeability of selected breakers.

C. Factory Tests: A complete test of the custom PLC logic and other special features including actual operation of all the breakers in the switchgear to demonstrate all possible conditions of operation. All procedures for system configuration shall be demonstrated and testing shall include attempted operation of all breakers to verify proper interlocking.
1. Provide contactors as necessary to simulate interfacing PLC control of the 480V switchgear with the medium voltage switchgear. Refer to the Sequence of Operation Specification for requirements.

D. Owner will witness all required factory tests. Contractor to provide accommodations if more than 50 mi from site. Notify Owner at least 14 days before date of tests and indicate their approximate duration.
1. Attendance or non-attendance by the Owner and/or their duly authorized representatives at factory tests shall not relieve the manufacturer of responsibility to correct any defects or items of non-conformance with these specifications discovered during site testing.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine areas and space conditions for compliance with requirements for secondary unit substations and other conditions affecting performance of work.

B. Examine roughing-in of conduits and grounding systems to verify the following:

1. Wiring entries comply with layout requirements.
2. Entries are within conduit-entry tolerances specified by manufacturer and no feeders will have to cross section barriers to reach load or line lugs.

C. Examine walls, floors, roofs, and concrete bases for suitable conditions for secondary unit substation installation.

D. Verify that ground connections are in place and that requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at secondary unit substation location.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.2 INSTALLATION

A. Install secondary unit substations on concrete bases.
   1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit and 4 inches high.
   2. Use 3,000-psi, twenty eight (28) day compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-Place Concrete."

B. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.

## 3.3 IDENTIFICATION

A. Identify field-installed wiring and components and provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."

B. Operating Instructions: Frame printed operating instructions for secondary unit substations, including key interlocking, control sequences, elementary single-line diagram, and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of secondary unit substation.

## 3.4 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

## 3.5 CLEANING

A. After completing equipment installation and before energizing, inspect unit components. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish. Vacuum interiors of secondary unit substation sections.

## 3.6 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including connections. Report results in writing.

B. Testing: Engage a qualified independent testing and inspecting agency to perform the following field tests and inspections and prepare test reports:

1. Perform each visual and mechanical inspection and electrical test according to NETA ATS. Certify compliance with test parameters.
2. After installing secondary unit substation but before primary is energized, verify that grounding system at the substation tested at the specified value or less.
3. After installing secondary unit substation and after electrical circuitry has been energized, test for compliance with requirements.
4. Set field-adjustable switches and circuit-breaker trip ranges as indicated and per short circuit analysis and recommendations of coordination.

    a. Remove and replace malfunctioning units and retest as specified above.

C. Switchgear Field Tests:

1. Visual and Mechanical Inspection:

    a. Inspect physical and mechanical condition.
    b. Inspect anchorage, alignment, grounding, and required area clearances.
    c. Verify the unit is clean and shipping bracing, loose parts, and documentation shipped inside cubicles have been removed.
    d. Verify that fuse and circuit-breaker sizes and types correspond to Drawings and coordination study as well as to the address of the circuit breaker that is used to identify it in microprocessor-communication software.
    e. Verify that current and voltage-transformer ratios correspond to Drawings.
    f. Confirm correct operation and sequencing of electrical and mechanical interlock systems.

        1) Attempt closure on locked-open devices. Attempt to open locked-closed devices.
        2) Make key exchange with devices operated in off-normal positions.

    g. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
    h. Inspect insulators for evidence of physical damage or contaminated surfaces.
    i. Verify correct barrier and shutter installation and operation.
    j. Exercise all active components.
    k. Inspect mechanical indicating devices for correct operation.

l. Verify that filters are in place and vents are clear.
m. Inspect control power transformers as follows:

1) Inspect for physical damage, cracked insulation, broken leads, connection tightness, defective wiring, and overall general condition.
2) Verify that primary- and secondary-fuse or circuit-breaker ratings match Drawings and comply with manufacturer's recommendations.
3) Verify correct functioning of drawout disconnecting and grounding contacts and interlocks.

n. A complete test of the custom PLC logic and other special features, including actual operation of all the breakers in the Load Center to demonstrate all possible conditions of operation. All procedures and the remote/local interlocks for system configuration shall be demonstrated and testing shall include attempted operation of all breakers to verify proper interlocking.

2. Electrical Tests:

a. Perform dc voltage insulation-resistance tests on each bus section, phase-to-phase and phase-to-ground, for one minute. If the temperature of the bus is other than plus or minus 20 deg. C, adjust the resulting resistance as provided in NETA ATS, Table 100.11.

1) Insulation-resistance values of bus insulation shall be according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Investigate and correct values of insulation resistance less than manufacturer's recommendations or NETA ATS, Table 100.1.
2) Do not proceed to the dielectric-withstand-voltage tests until insulation-resistance levels are raised above minimum values.

b. Perform a dielectric-withstand-voltage test on each bus section, each phase-to-ground with phases not under test grounded, according to manufacturer's published data. If manufacturer has no recommendation for this test, it shall be conducted according to NETA ATS, Table 100.2. Apply the test voltage for one minute.

1) If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric-withstand-voltage test, the test specimen is considered to have passed the test.

c. Perform insulation-resistance tests on control wiring with respect to ground. Applied potential shall be 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable. Test duration shall be one minute. For units with

solid-state components or control devices that cannot tolerate the applied voltage, follow the manufacturer's recommendation.

1) Minimum insulation-resistance values of control wiring shall not be less than 2 megohms.

d. Voltage Transformers:

1) Perform secondary wiring integrity test. Verify correct potential at all devices.
2) Verify secondary voltages by energizing the primary winding with system voltage.

e. Perform current-injection tests on the entire current circuit in each section of switchgear.

1) Perform current tests by secondary injection with magnitudes such that a minimum current of 1.0 A flows in the secondary circuit. Verify correct magnitude of current at each device in the circuit.
2) Perform current tests by primary injection with magnitudes such that a minimum of 1.0 A flows in the secondary circuit. Verify correct magnitude of current at each device in the circuit.

f. Verify operation of space heaters.
g. Perform phasing checks on double-ended or dual-source switchgear to ensure correct bus phasing from each source.

D. Dry-Type Transformer Section Field Tests (Where Transformer is Provided):

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.
b. Inspect anchorage, alignment, and grounding.
c. Verify that resilient mounts are free and that any shipping brackets have been removed.
d. Verify the unit is clean.
e. Verify that alarm, control, and trip settings on temperature and level indicators are set and operate within manufacturer's recommended settings.
f. Verify that cooling fans operate and that fan motors have correct overcurrent protection.
g. Perform specific inspections and mechanical tests recommended by the manufacturer.
h. Verify that as-left tap connections are as specified.
i. Verify the presence of surge arresters and that their ratings are as specified.

2. Electrical Tests:

   a. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index; the value of the index shall not be less than 1.0.
   b. Perform power-factor or dissipation-factor tests on windings according to the test equipment manufacturer's published data. Investigate and correct power-factor values that exceed:

      1) 2.0 percent for power transformers.
      2) 5.0 percent for distribution transformers.

   c. Measure core insulation resistance at 500-V dc if the core is insulated and the core ground strap is removable. Core insulation-resistance values shall not be less than 1 megohm at 500-V dc.
   d. Perform a power-factor or dissipation-factor tip-up test on windings greater than 2.5 kV. Tip-up test result exceeding 1.0 percent shall be investigated.
   e. Perform turns-ratio tests at all tap positions. The test results shall not deviate by more than one-half percent from either the adjacent coils or the calculated ratio. If the test fails, replace the transformer.
   f. Perform an excitation-current test on each phase. The typical excitation-current test data pattern for a three-legged core transformer is two similar current readings and one lower current reading. Investigate and correct if the test shows a different pattern.
   g. Measure the resistance of each winding at each tap connection.
   h. Perform an applied-voltage test on all high- and low-voltage windings-to-ground. See IEEE C57.12.91, Sections 10.2 and 10.9. The ac dielectric-withstand-voltage test result shall not exceed 75 percent of factory test voltage for one-minute duration. The dc dielectric-withstand-voltage test result shall not exceed 100 percent of the ac rms test voltage specified in IEEE 57.12.91, Section 10.2, for one-minute duration. If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric-withstand-voltage test, the test specimen is considered to have passed the test.
   i. Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.

E. Low-Voltage Power Circuit-Breaker Field Tests:

1. Visual and Mechanical Inspection:

   a. Inspect physical and mechanical condition.
   b. Inspect anchorage, alignment, and grounding.

c. Verify that all maintenance devices are available for servicing and operating the breaker.
d. Verify the unit is clean.
e. Verify that the arc chutes are intact.
f. Inspect moving and stationary contacts for condition and alignment.
g. Verify that primary and secondary contact wipe and other dimensions vital to satisfactory operation of the breaker are correct.
h. Perform mechanical operator and contact alignment tests on both the breaker and its operating mechanism according to manufacturer's published data.
i. Verify cell fit and element alignment.
j. Verify racking mechanism operation.
k. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
l. Perform adjustments for final protective-device settings according to coordination study provided by end user.
m. Record as-found and as-left operation counter readings.

2. Electrical Tests:

a. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to ground with switch closed, and across each open pole. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS, Table 100.1. Insulation-resistance values shall be according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Values of insulation resistance less than this table or manufacturer's recommendations shall be investigated.
b. Measure contact resistance across each power contact of the circuit breaker. Microhm or dc millivolt drop values shall not exceed the high levels of the normal range as indicated in manufacturer's published data. If manufacturer's published data is not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
c. Determine long-time pickup and delay by primary current injection. Long-time pickup values shall be as specified, and the trip characteristic shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors. If manufacturer's curves are not available, trip times shall not exceed the value shown in NETA ATS, Table 100.7.
d. Determine short-time pickup and delay by primary current injection. Short-time pickup values shall be as specified, and the trip characteristic shall not exceed manufacturer's published time-current tolerance band.

e. Determine ground-fault pickup and delay by primary current injection. Ground-fault pickup values shall be as specified, and the trip characteristic shall not exceed manufacturer's published time-current tolerance band.
f. Determine instantaneous pickup value by primary current injection. Instantaneous pickup values shall be as specified and within manufacturer's published tolerances. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.8.
g. Test functions of the trip unit by means of secondary injection. Pickup values and trip characteristic shall be as specified and within manufacturer's published tolerances.
h. Perform minimum pickup voltage tests on shunt trip and close coils according to manufacturer's published data. Minimum pickup voltage of the shunt trip and close coils shall conform to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.20.
i. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
j. Verify correct operation of any auxiliary features, such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free operation, anti-pump function, and trip unit battery condition. Reset trip logs and indicators. Auxiliary features shall operate according to manufacturer's published data.
k. Verify operation of charging mechanism. The charging mechanism shall operate according to manufacturer's published data.

## 3.7 FOLLOW-UP SERVICE

A. Voltage Monitoring and Adjusting: After Substantial Completion, if requested by Owner, but not more than six months after Final Acceptance, perform the following voltage monitoring:

1. During a period of normal load cycles as evaluated by Owner, perform seven days of three-phase voltage recording at the outgoing section of each secondary unit substation. Use voltmeters with calibration traceable to the National Institute of Science and Technology standards and with a chart speed of not less than 1 inch per hour. Voltage unbalance greater than 1 percent between phases, or deviation of any phase voltage from the nominal value by more than plus or minus 5% during the test period, is unacceptable.
2. Corrective Action: If test results are unacceptable, perform the following corrective action, as appropriate:

a. Adjust transformer taps.
b. Rebalance loads.
c. Prepare written request for voltage adjustment by electric utility.

3. Retests: Repeat monitoring, after corrective action has been performed, until satisfactory results are obtained.
4. Report: Present field copy and prepare a written report covering monitoring performed and corrective action taken.

B. Infrared Scanning: Perform as specified in Division 26 Section "Medium-Voltage Switchgear."

## 3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain systems. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 261116

# SECTION 261200 - MEDIUM-VOLTAGE TRANSFORMERS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 26.

### 1.2 DESCRIPTION OF WORK

A. This section provides the specification for the Medium-Voltage Transformers and related accessories that shall be furnished by the manufacturer.

### 1.3 DELIVERY

A. The supplier's shipping company shall verify all height, weight, and traffic limitations when considering pricing and actual delivery. The delivery at the site for the equipment unloading shall be scheduled for normal working hours of Monday through Friday (7:00am – 3:00pm). The actual delivery through the University of Maryland, Baltimore campus must be scheduled with the University to prevent travel through major campus activity days. The shipper shall consider that it may take up to 4 hours before the switchgear is lifted off the delivery truck and the truck is free to leave.

### 1.4 SUMMARY

A. This Section includes the following types of transformers with medium-voltage primaries:
   1. Dry-type distribution and power transformers.

### 1.5 DEFINITIONS

A. NETA ATS: Acceptance Testing Specification.

### 1.6 SUBMITTALS

A. Compliance Statement as described under the Quality Assurance section of this specification.

B. Submittals:
   1. Shop Drawings: Diagram power, signal, and control wiring.
   2. Coordination Drawings: Floor plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

      a. Dimensioned plan and elevations with tap, control power transformer, fan and temperature monitor locations, and phase, neutral and ground connection locations.
      b. Enclosure details, including removable panel descriptions, louver locations, control wiring routing, sheet metal gauge, and painting details.
      c. Terminal locations and details for phase, neutral and ground connections.
      d. Coil conductor materials and construction.
      e. Insulation materials.
      f. Test data sheets for similar transformers with test data on load losses, no-load losses and sound level.
      g. Temperature control system description, including details on the control power transformer, fans, temperature monitor, alarms and hinged panel for the monitor.
      h. Schematic and connection diagrams for the temperature control system.
      i. Full size copy of the nameplate.
      j. Coil-to-bus/line connection materials, support and details.
      k. Bus bar and line termination connection and support details.
      l. ANSI Damage curve for secondary unit substation transformers.
      m. Detailed location, mounting and wiring of the lightning arrestors.

   3. Qualification Data: For testing agency.
   4. Source quality-control test reports.
   5. Field quality-control test reports.
   6. Follow-up service reports.
   7. Operation and Maintenance Data: For transformer and accessories to include in emergency, operation, and maintenance manuals.

## 1.7 QUALITY ASSURANCE

A. Compliance Statement: The Manufacturer/Equipment Vendor shall include a Compliance Statement, listing each Specification Section, and Part 1, 2, and 3 Sub-Sections, stating, paragraph-by-paragraph, compliance with the Specification, each minor nonconformity that is within the intent of the Specification, and proposed nonconformities. Provide short description of minor nonconformities, and detailed explanation of other nonconformities.

B. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as

defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

C. Product Options: Drawings indicate size, profiles, and dimensional requirements of transformers and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Comply with IEEE C2 and NESC.

F. Comply with ANSI C57.12.10, ANSI C57.12.28, IEEE C57.12.70, and IEEE C57.12.80.

G. Comply with NFPA 70.

## 1.8 DELIVERY, STORAGE, AND HANDLING

A. Store transformers protected from weather so condensation will not form on or in units. Provide temporary heating according to manufacturer's written instructions.

## 1.9 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate installation of louvers, doors, spill retention areas, and sumps. Coordinate installation so no piping or conduits are installed in space allocated for medium-voltage transformers except those directly associated with transformers.

## 1.10 WARRANTY/GUARANTEE

A. See Division 26 Specification Section “Basic Electrical Requirements’ for warranty and guarantee requirements.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. GE Electrical Distribution & Control.
2. Square D; Schneider Electric.
3. Virginia Transformer Corp.
4. ABB Power T&D Co. Inc.
5. Sunbelt Transformer
6. Waukesha Electric Systems, Inc.

### 2.2 DRY-TYPE DISTRIBUTION AND POWER TRANSFORMERS

A. Description: NEMA ST 20, IEEE C57.12.01, ANSI C57.12.51, UL 1562 listed and labeled, dry-type, two (2)_winding transformers. Provide indoor or outdoor rating as required on drawings.

1. Indoor, Transformer for Substation 8, BRB: Indoor, ventilated, cast coil/encapsulated coil, with primary and secondary windings individually cast in epoxy; with insulation system rated at $185^0$C with an $80^0$C average winding temperature rise above a maximum ambient temperature of $40^0$C.
2. Outdoor, Transformers on Howard Hall Roof: Outdoor, ventilated, cast coil/encapsulated coil with primary and secondary windings individually cast in epoxy; with insulation system rated at 185 deg C with an 80 deg C average winding temperature rise above maximum ambient of 40 deg C.

B. Primary Connection: Air terminal compartment with hinged door. Tin-plated copper bar for incoming line termination, predrilled to accept terminals for indicated conductors.

C. Secondary Connection for outdoor transformers: Air terminal compartment with hinged door. Tin-plated copper bar for incoming line termination, predrilled to accept terminals for indicated conductors.

D. Secondary Connection for indoor, substation transformer: Transition terminal compartment with connection pattern to match switchgear.

E. Insulation Materials: IEEE C57.12.01, rated at $220^0$C.

F. Insulation Temperature Rise: $115^0$C, maximum rise above $40^0$C.

G. Basic Impulse Level: 95kV.

H. Full-Capacity Voltage Taps: Four nominal 2.5% taps, two (2) above and two (2) below rated primary voltage.

I. Cooling System: Class AA/FA, self-cooled, and with forced-air-cooled rating, complying with IEEE C57.12.01.

J. Sound level may not exceed sound levels listed in NEMA TR 1, without fans operating.

K. Impedance: 5.75% +/-7.5% tolerance.

L. High-Temperature Alarm: Sensor at transformer with local audible and visual alarm and contacts for remote alarm. Square-D, Model 98 Transformer Temperature Monitor for remote recording of transformer winding temperatures.

## 2.3 IDENTIFICATION DEVICES

A. Nameplates: Engraved, laminated-plastic or metal nameplate for each transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section "Identification for Electrical Systems."

## 2.4 SOURCE QUALITY CONTROL

A. Factory Tests: Perform design and routine tests according to standards specified for components. Conduct transformer tests according to ANSI C57.12.51.

B. Factory Tests: Perform the following factory-certified tests on each transformer:

1. Resistance measurements of all windings on rated-voltage connection and on tap extreme connections.
2. Ratios on rated-voltage connection and on tap extreme connections.
3. Polarity and phase relation on rated-voltage connection.
4. No-load loss at rated voltage on rated-voltage connection.
5. Excitation current at rated voltage on rated-voltage connection.
6. Impedance and load loss at rated current on rated-voltage connection and on tap extreme connections.
7. Applied potential.
8. Induced potential.
9. Temperature Test: If transformer is supplied with auxiliary cooling equipment to provide more than one rating, test at lowest kilovolt-ampere Class OA or Class AA rating and highest kilovolt-ampere Class OA/FA or Class AA/FA rating.

    a. Temperature test is not required if record of temperature test on an essentially duplicate unit is available.

10. Owner will witness all required factory tests. Notify Owner at least 14 days before date of tests and indicate their approximate duration.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for medium-voltage transformers.

B. Examine roughing-in of conduits and grounding systems to verify the following:

1. Wiring entries comply with layout requirements.
2. Entries are within conduit-entry tolerances specified by manufacturer and no feeders will have to cross section barriers to reach load or line lugs.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

D. Verify that ground connections are in place and that requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

A. Install indoor transformers on concrete bases.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit and 4 inches high.
2. Use 3000-psi concrete twenty eight (28) day compressive-strength, and reinforcement as specified in Division 03 Section "Cast-in-Place Concrete."
3. Install dowel rods to connect concrete bases to concrete floor. Unless otherwise indicated, install dowel rods on eighteen (18) inch centers around full perimeter of base.
4. Install epoxy-coated anchor bolts, for supported equipment, that extend through concrete base and anchor into structural concrete floor.
5. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
6. Tack-weld or bolt transformers to channel-iron sills embedded in concrete bases. Install sills level and grout flush with floor or base.

B. Transformers on roof will be installed on steel framing. Refer to structural drawings for requirements.

C. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.

## 3.3 IDENTIFICATION

A. Identify field-installed wiring and components and provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."

## 3.4 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

C. Connect wiring according to Division 26 Section "Medium-Voltage Electrical Power Conductors and Cables."

## 3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:

1. After installing transformers but before primary is energized, verify that grounding system at substation is tested at specified value or less.
2. After installing transformers and after electrical circuitry has been energized, test for compliance with requirements.
3. Perform visual and mechanical inspection and electrical tests stated in NETA ATS. Certify compliance with test parameters.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Dry-Type Transformer Field Tests:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.
b. Inspect anchorage, alignment, and grounding.
c. Verify that resilient mounts are free and that any shipping brackets have been removed.
d. Verify the unit is clean.
e. Verify that alarm, control, and trip settings on temperature and level indicators are set and operate within manufacturer's recommended settings.
f. Verify that cooling fans operate and that fan motors have correct overcurrent protection.
g. Perform specific inspections and mechanical tests recommended by the manufacturer.
h. Verify that as-left tap connections are as specified.
i. Verify the presence of surge arresters and that their ratings are as specified.

2. Electrical Tests:

a. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index; the value of the index shall not be less than 1.0.
b. Perform power-factor or dissipation-factor tests on windings according to the test equipment manufacturer's published data. Investigate and correct power-factor values that exceed:
c. 2.0 percent for power transformers.
d. 5.0 percent for distribution transformers.
e. Measure core insulation resistance at 500-V dc if the core is insulated and the core ground strap is removable. Core insulation-resistance values shall not be less than 1 megohm at 500-V dc.
f. Perform a power-factor or dissipation-factor tip-up test on windings greater than 2.5 kV. Tip-up test result exceeding 1.0 percent shall be investigated.
g. Perform turns-ratio tests at all tap positions. The test results shall not deviate by more than one-half percent from either the adjacent coils or the calculated ratio. If the test fails, replace the transformer.
h. Perform an excitation-current test on each phase. The typical excitation-current test data pattern for a three-legged core transformer is two similar current readings and one lower current reading. Investigate and correct if the test shows a different pattern.
i. Measure the resistance of each winding at each tap connection.
j. Perform an applied-voltage test on all high- and low-voltage windings-to-ground. See IEEE C57.12.91, Sections 10.2 and 10.9. The ac dielectric-withstand-voltage test result shall not exceed 75 percent of factory test

voltage for one-minute duration. The dc dielectric-withstand-voltage test result shall not exceed 100 percent of the ac rms test voltage specified in IEEE 57.12.91, Section 10.2, for one-minute duration. If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric-withstand-voltage test, the test specimen is considered to have passed the test.

k. Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.

D. Remove and replace malfunctioning units and retest as specified above.

E. Test Reports: Prepare written reports to record the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Test results that do not comply with requirements and corrective actions taken to achieve compliance with requirements.

## 3.6 FOLLOW-UP SERVICE

A. Voltage Monitoring and Adjusting: If requested by owner, perform the following voltage monitoring after Substantial Completion but not more than six months after Final Acceptance:

1. During a period of normal load cycles as evaluated by owner, perform seven days of three-phase voltage recording at secondary terminals of each transformer. Voltage unbalance greater than 1 percent between phases, or deviation of any phase voltage from nominal value by more than plus or minus 5% during test period, is unacceptable.
2. Corrective Actions: If test results are unacceptable, perform the following corrective actions, as appropriate:

a. Adjust transformer taps.

3. Retests: After corrective actions have been performed, repeat monitoring until satisfactory results are obtained.
4. Report: Prepare written report covering monitoring and corrective actions performed.

B. Infrared Scanning: Perform as specified in Division 26 Section "Medium-Voltage Switchgear."

END OF SECTION 261200

# SECTION 261300 - MEDIUM-VOLTAGE SWITCHGEAR

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 26.

### 1.2 SUMMARY

A. This Section includes metal-clad, circuit-breaker switchgear with the following optional components, features, and accessories:

1. Copper, silver-plated main bus at connection points
2. Communication modules.
3. Relays.
4. Surge arresters.
5. Provisions for future devices.
6. Control battery system.
7. Mimic bus.

### 1.3 DEFINITIONS

A. ATS: Acceptance Testing Specifications.

B. GFCI: Ground-Fault Circuit Interrupter.

### 1.4 SUBMITTALS

A. Product Data: For each type of switchgear and related equipment, include the following:

1. Rated capacities, operating characteristics, furnished specialties, and accessories for individual circuit breakers.
2. Time-current characteristic curves for overcurrent protective devices, including circuit-breaker relay trip devices.

B. General arrangement drawings of switchgear and accessories complete with dimensions. Include plan view and section view drawings. Indicate required clearances and overall dimensions.

C. Shop Drawings: For each type of switchgear and related equipment, include the following:

1. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show method of field assembly and location and size of each field connection. Include the following:

   a. Tabulation of installed devices with features and ratings.
   b. Outline and general arrangement drawing showing dimensions, shipping sections, and weights of each assembled section.
   c. Drawing of cable termination compartments showing preferred locations for conduits and indicating space available for cable terminations.
   d. Floor plan drawing showing locations for anchor bolts and leveling channels.
   e. Current ratings of buses.
   f. Short-time and short-circuit ratings of switchgear assembly.
   g. Nameplate legends.
   h. Mimic-bus diagram.
   i. Metering provisions with approval by Owner.

2. Wiring Diagrams: For each type of switchgear and related equipment, include the following:

   a. Power, signal, and control wiring.
   b. Three-line diagrams of current and future secondary circuits showing device terminal numbers and internal diagrams.
   c. Schematic control diagrams.
   d. Diagrams showing connections of component devices and equipment.
   e. Schematic diagrams showing connections to remote devices including SCADA remote terminal unit.

3. Circuit Breaker Control Schematics and Switchgear point to point wiring diagrams.
   a. Control and Protective relay diagrams including the following:
   b. Instrument transformer ratios, accuracy class, transformer wiring connections, and polarities.
   c. Control wiring size and type.
   d. All external wiring connections for each protective relay.
   e. All switchgear drawings prepared by the Equipment Vendor shall be submitted to the Engineer in AutoCAD format in addition to hard copy submittals. Electronic files to be submitted include:
   f. Circuit Breaker Control Schematics for each breaker cubical.
   g. Point to Point Wiring Diagrams for each switchgear cubical.
   h. Switchgear Three Line Diagrams.
   i. Switchgear Single Line Diagrams

j. Schematic diagrams showing connections to remote devices including SCADA remote terminal unit.

D. Utility Review: The shop drawings will be submitted to the Utility for review and approval after review and approval by the Engineer. The manufacturer shall provide a compliance statement with the shop drawings as outlined in Section 1.5 of this specification for all requirements shown in the latest version of BGE CSR-2 which shall be considered part of the contract documents.

E. Coordination Drawings: Floor plans showing dimensioned layout, required working clearances, and required area above and around switchgear where piping and ducts are prohibited. Show switchgear layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Identify field measurements.

F. Relay Electronic Files: Settings files in electronic format shall be provided for review and approval prior to factory witness testing. Default settings for all protective functions shall be provided for the initial review and for factory testing. The Engineer will provide the final set points to be implemented by the certified testing agent in the field.

G. Battery Calculations: Provide calculations showing battery size and quantity is sufficient for supplying all connected and planned future equipment as shown on the drawings.

H. Samples: Representative portion of mimic bus with specified finish. Manufacturer's color charts showing colors available for mimic bus.

I. Qualification Data: For testing agency.

J. Source quality-control test reports.

K. Field quality-control test reports.

L. Operation and Maintenance Data: For switchgear and switchgear components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
2. Time-current curves, including selectable ranges for each type of overcurrent protective device.
3. As-Left relay settings files in electronic format on a DVD or USB thumb drive.

## 1.5 QUALITY ASSURANCE

A. Compliance Statement: The Manufacturer/Equipment Vendor shall include a Compliance Statement, listing each Specification Section, and Part 1, 2, and 3 Sub-Sections, stating,

paragraph-by-paragraph, compliance with the Specification, each minor nonconformity that is within the intent of the Specification, and proposed nonconformities. Provide short description of minor nonconformities, and detailed explanation of other nonconformities.

B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

C. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7.

D. Source Limitations: Obtain each type of switchgear and associated components through one source from a single manufacturer.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

F. Comply with IEEE C2.

## 1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver in sections of lengths that can be moved past obstructions in delivery path as indicated.

B. Store switchgear indoors in clean dry space with uniform temperature to prevent condensation. Protect switchgear from exposure to dirt, fumes, water, corrosive substances, and physical damage.

## 1.7 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation at indicated ampere ratings for the following conditions:

1. Ambient temperature not exceeding $122^0$F
2. Altitude of 3300 feet above sea level.

B. Installation Pathway: Remove and replace building components and structures to provide pathway for moving switchgear into place.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchgear, including clearances between switchgear and adjacent surfaces and other items. Comply with indicated maximum dimensions.

D. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify Owner no fewer than 10 days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without Owner's written permission.

3. Outages to existing loads shall occur during off hours.

    a. If contractor elects to do outages or switchovers during normal hours then contractor shall submit a plan to be approved by the owner and provide temporary power at no additional cost.

## 1.8 COORDINATION

A. Coordinate layout and installation of switchgear and components with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required clearances for workspace and equipment access doors and panels.

B. Coordinate size and location of concrete bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

## 1.9 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: Two of each type and rating used. Include spares for future transformers, control power circuits, and fusible devices.
2. Indicating Lights: Two of each type installed.
3. Touchup Paint: One container of paint matching enclosure finish, each 0.5 pint.

B. Maintenance Tools: Furnish tools and miscellaneous items required for interrupter switchgear test, inspection, maintenance, and operation. Include the following:

1. Fuse-handling tool.
2. Ground cable, bare copper #4/0, of at least 10'-0" length with clamps at each end.
3. Linemen's gloves with a minimum 13kV rating.
4. Extension rails, lifting device, transport or dockable dolly or mobile lift, and all other items necessary to remove circuit breaker from housing and transport to remote location.
5. Racking handle to move circuit breaker manually between connected and disconnected positions, and a secondary test coupler to permit testing of circuit breaker without removal from switchgear.
6. Spare fuse storage cabinet: with piano hinged doors and key lockable. Sized for above listed maintenance tools.

1.10 WARRANTY/GUARANTEE

A. See Division 26 Specification Section "Basic Electrical Requirements' for warranty and guarantee requirements.

## PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the manufacturers specified.

2.2 MANUFACTURED UNITS

A. Description: Factory assembled and tested, and complying with IEEE C37.20.1 and BGE CSR-2.

B. Ratings: Suitable for application in 3-phase, 60-Hz, solidly grounded-neutral system.

C. System Voltage: 13.2 kV nominal; 15 kV maximum.

2.3 METAL-CLAD, CIRCUIT-BREAKER SWITCHGEAR

A. Available Manufacturers:
1. Eaton Corporation; Cutler-Hammer Products.
2. Square D; Schneider Electric.
3. Powercon

B. All medium-voltage switchgear covered in this section shall be supplied from one manufacturer/supplier.

C. Comply with IEEE C37.20.3.

D. Nominal Interrupting-Capacity Class: 1000 MVA.

E. Ratings: Comply with IEEE C37.04.

1. North Switching Station Main-Bus Rating: 2000 A, continuous.

2. Howard Hall and Paralleling Switchgear Main-Bus Rating: 1200 A, continuous.

F. Switchgear Assembly:

1. Switchgear enclosure, busbar assemblies, circuit breakers, metering, protection, and switchgear controls shall be factory assembled and tested, and shall have ratings as described in the paragraphs below, in accordance with the Standards listed in Part 1 of this Section.

2. The switchgear assembly shall consist of individual vertical sections housing various combinations of circuit breakers and auxiliaries, bolted to form a rigid metal-clad switchgear assembly. Metal side sheets shall provide grounded barriers between adjacent structures and solid removable metal barriers shall isolate the major primary sections of each circuit. The switchgear shall be arranged in a 2 high configuration, with two hinged rear covers furnished for each vertical section for circuit isolation and ease of handling.

3. The stationary primary contacts shall be silver-plated and recessed within insulating tubes. A steel shutter shall automatically cover the stationary primary disconnecting contacts when the breaker is in the disconnected position or out of the cell.

G. Circuit Breakers: Three-pole, single-throw, electrically operated, drawout-mounting units using three individual, vacuum-sealed interrupter modules and including the following features:

1. Designed to operate at rated voltage to interrupt fault current within its rating within three cycles of trip initiation. For systems with X/R ratio of 17 or less, transient voltage during interruption shall not exceed twice the rated line-to-ground voltage of the system.
2. Contact-Wear Indicator: Readily accessible to field maintenance personnel.
3. Minimum of six Type A and six Type B spare contacts.
4. Interchangeability: Circuit breakers are interchangeable with vacuum circuit breakers of same current and interrupting ratings.

a. North Switching Station:

1) Current Rating of Main Circuit Breaker: 2000 A.
2) Continuous Current Rating of Tie Circuit Breaker: 2000 A.
3) Continuous Current Rating of Feeder Circuit Breaker: 1200 A.

b. Howard Hall and Paralleling Switchgear:
1) Current Rating of Main Circuit Breaker: 1200 A.
2) Continuous Current Rating of Tie Circuit Breaker: 1200 A.
3) Continuous Current Rating of Feeder Circuit Breaker: 1200 A.

5. Operating Mechanism: Electrically charged, mechanically and electrically trip-free, stored-energy operated.

a. Closing speed of moving contacts to be independent of both control and operator.
b. Design mechanism to permit manual charging and slow closing of contacts for inspection or adjustment.

1) Control Power: 125V dc for closing and tripping.

c. Provide shunt trip capability independent of overcurrent trip.

d. Circuit breaker shall be capable of being operated and racked in with the door closed.

H. Test Accessories: Relay and meter test plugs.

I. Low-DC-Voltage Alarm: Switchgear shall have a monitor for dc control power voltage with a remote contact output and Factory set alarm value at 80% of full-charge voltage.

J. Grounding and Testing Device: Suitable for phasing out, testing, and grounding switchgear bus or feeder if device is installed in place of circuit breaker. Include the following:

1. Portable Grounding and Testing Device: Interchangeable with drawout-mounting, medium-voltage circuit breakers to provide interlocked electrical access to either bus or feeder; electrically operated.
2. System control cabinet permanently mounted near switchgear.
3. Portable Remote-Control Station: For grounding and testing device.
4. Control-Cabinet Coupler Cable: Of adequate length to connect device inserted in any switchgear cubicle and control cabinet.
5. Remote-Control Coupler Cable: Fifty (50) feet long to connect control cabinet and portable remote-control station.
6. Permanent Control Power Wiring: From control cabinet to power source.
7. Protective Cover: Fabricated of heavy-duty plastic and fitted to device.
8. Approval of Grounding and Testing Device System: Obtain approval of final system design from utility company and agency designated by Owner to handle future maintenance of medium-voltage switchgear.

K. Circuit-Breaker Test Cabinet: Separately mounted and containing push buttons for circuit-breaker closing and tripping, control relay, fuses, and secondary coupler with cable approximately one hundred eight (108) inches long. Include a set of secondary devices for operating circuit breaker if removed from switchgear and moved near test cabinet. Include provision for storage of test and maintenance accessories in cabinet.

L. Utility Compartment for North Switching Station: Dedicated BGE metering compartments to be provided in accordance with BGE standard CSR-2 including, but not limited to:
   1. Provide mounting provisions for three (3) BGE surge arrestors. The surge arrestors will be furnished and installed by BGE. The switchgear manufacturer is responsible for providing the tap wire from the bus connection to the surge arrestor. The surge arrestor will be 10kV duty cycle, 8.4 kV MCOV metal-oxide distribution class.
   2. The phase arrangement shall be A, B, C from left to right, top to bottom and front to back when viewed from the front of the switchgear.
   3. The BGE metering compartment shall contain provisions for mounting the BGE revenue metering current and potential transformers, potential transformer fuses, and all necessary drilling and bolting hardware. The revenue metering current transformers, potential transformers, and potential transformer fuses will be furnished and installed by BGE.
      a. The current transformers provided by BGE will have the same dimensions as GE JKM-5.
      b. A completely isolated compartment shall be provided in the metering unit for the installation of the BGE revenue metering potential transformers.
      c. The potential transformers provided by BGE will have the same dimensions as GE type JVM-5.
   4. Each metering unit compartment housing the potential and current transformers shall be provided with an interior protective hinged screen barrier or metal panel to prevent inadvertent physical contact with any energized part with the metering cubicle door open. The interior hinged screen barrier of metal panels shall be bolted closed with captive fasteners or other acceptable latching devices.
   5. All primary connections from the switchgear bus to the current transformer terminals, from the switchgear bus to the potential transformer fuses, and from the fuses to the potential transformers shall be provided and installed by the manufacturer.
   6. Primary taps from the switchgear bus to the potential transformer fuses shall be connected to the switchgear bus on the supply side terminals of the current transformer primary bus connections.

## 2.4 CONTROL SYSTEM

A. Refer to 262313 Switchgear Controls and Automation Specification.

B. Control hardware and components shall be located out of the medium voltage switchgear in separate HMI/control cabinets as indicated on the drawings.

C. The Master Control Panel (MCP) shall be located in Howard Hall. The MCP shall contain a Master Auto/Manual (MAM) Switch that disables automated controls for the

entire control system. HMI shall display an alarm when MAM switch is placed in Manual.

D. All Local Control Panels (LCPs) shall contain a physical Station Auto/Manual (SAM) Switch. The SAM switch shall disable automated controls for that station only. HMI shall display an alarm when SAM switch is placed in manual. There shall be SAM switches for the following Switchgear:
   1. Howard Hall 15kV Switchgear and Howard Hall Generator Paralleling Switchgear (One SAM switch controls both switchgear)
   2. Peaking Plant Paralleling Switchgear
   3. North Switching Station
   4. Howard Hall 480V Switchgear
   5. Bressler Research Building 480V Switchgear

E. In addition to the MAM and SAM switches, Local/Remote switches shall be provided. The Local/Remote switches shall prevent any remote control (automated or manually initiated from HMI) of the switchgear from the control system when in "Local". When Local/Remote switch is in "Local" the HMI shall display an alarm. Switch shall be pad-lockable. The Local/Remote switch shall be located on the switchgear for each specific bus. Provide Local/Remote Switches for the following:
   1. Howard Hall 15kV Switchgear (One L/R Switch for both buses)
   2. Howard Hall Generator Paralleling Switchgear (One L/R Switch for both buses)
   3. Peaking Plant Paralleling Switchgear (One L/R Switch for both buses)
   4. North Switching Station Bus NA
   5. North Switching Station Bus NB
   6. North Switching Station Bus NC
   7. North Switching Station Bus ND
   8. Howard Hall 480V Switchgear (One L/R Switch for both buses)
   9. Bressler Research Building 480V Switchgear (One L/R Switch for both buses)

## 2.5 GENERATOR CONTROL FEATURES

A. Provide manual generator set voltage and frequency control via the HMI with digital synchronizing scopes.

B. Each power source breaker shall be provided with digital manual synchronizing scopes and associated (25) sync-check protective relays. The synchronizing scopes shall be displayed on each HMI for all sources on the system on individual screens for each source. Software protective relays are not acceptable for manual operation functions.

C. Manual operation at the minimum shall allow a single generator to be placed on the bus and to carry the facility loads on a single engine generator up to the engine generator capacity. Each generator shall have the capability to be manually placed on the bus.

D. Demonstrate to the facility personnel the capability to manually control an engine generator without the use of the automation system.

2.6 FABRICATION

A. Indoor Enclosure: Free-standing, self-supporting unit constructed of not less than 11 gauge sheet steel, free from cracks, dents, seams and other defects.

B. Finish: Manufacturer's standard gray finish over rust-inhibiting primer on phosphatizing-treated metal surfaces.

C. Main Bus: The main bus shall be copper with fluidized bed epoxy flame-retardant and track-resistant insulation. The bus supports between units shall be flame-retardant, track-resistant, cycloaliphatic epoxy. The switchgear shall be constructed so that all buses, bus supports, and connections shall withstand stresses that would be produced by currents equal to the momentary ratings of the circuit breakers. Insulated copper main bus shall be provided and have provisions for future extension. All bus joints shall be silver plated, to standard 0.1 mil thickness, bolted and insulated with easily installed boots. The bus shall be braced to withstand fault currents equal to or greater than the momentary rating of the switchgear. The temperature rise of the bus and connections shall be in accordance with ANSI standards and documented by design tests. All termination pads shall be equipped with grounding studs.

D. Ground Bus: Copper, minimum size 0.25 by 2 inches, full length of switchgear. The ground bus shall be extended out into the termination areas of each breaker compartment. Within the termination areas, the ground bus shall be sized to accommodate the terminations for the cable shields and the 4/0 AWG (600V) feeder ground cable and equipped with grounding studs.

E. Bus Insulation: Covered with flame-retardant insulation.

F. Shutters: Metal shutters drop into place as each circuit breaker is racked out, and separate the busbars from the circuit breaker compartment with a grounded metal barrier when the circuit breaker is withdrawn.

G. Bus Transition Unit: Arranged to suit bus and adjacent units.

H. Incoming-Line Unit: Arranged to suit incoming line.

I. Outgoing Feeder Units: Arranged to suit distribution feeders.

J. Auxiliary Compartments: Arranged to suit house meters, relays, controls, and auxiliary equipment; isolated from medium-voltage components.

K. Doors: Hinged front doors, in accordance with ANSI construction, for each circuit breaker and metering & control compartment, with drop-bar to keep the door open during

servicing, and fitted with padlocking attachment to prevent unauthorized access. Hinged rear doors, with three-point latching mechanism, drop-bar to keep the door open during servicing, and handle with lock. Provide 2 keys for each lock.

1. Provide a 4 inch minimum infra-red window in each rear door, positioned for optimal viewing of terminations and busbar/lug connections during thermographic surveying.

L. Control Wiring: Factory installed type SIS rated 600 volt, 90 degrees C, furnished with wire markers at each termination except where installation environments (temperature and chemical) require specialized insulation systems. Wires shall terminate on terminal blocks with marker strips numbered in agreement with detailed connection diagrams complete with bundling, lacing, and protection. Complying with the following:

1. Flexible stranded conductors for No. 12 AWG and larger.

2. Minimum size of #12 AWG.

3. All current transformer circuits shall be #10 AWG and wired through shorting type terminal blocks.

4. All control wiring shall be 600V SIS cable. The use of nylon is not acceptable.

5. All cables shall be terminated on terminal blocks using AMP or Burndy ring type solid un-insulted barrel terminations.

6. Each control wire shall be uniquely numbered at each end and at each termination point.

7. No more than two wires shall be connected at a single wiring terminal. Thread on wire nuts or split bolt connectors are not permitted. In-line control wire splices are not acceptable.

8. Terminal block shall be provided for all conductors requiring connection to circuits external to the specified equipment, where internal circuits cross shipping splits, and where equipment part replacement and maintenance will be facilitated.

9. Leave slack in bundled conductors at hinges and interconnections between shipping units. Wiring traversing hinges or other forms of flexible constructions shall be high stranded and shall traverse the area of bending normal to the plane of rotation so as to impart a twisting rather than a bending motion to the cable or wire bundle.

10. All control cables entering enclosures shall be secured by their jackets to the enclosure support to provide strain relief for the cable wire terminations.

11. All terminal blocks shall be removable screw or stud type. Compression type blocks are not acceptable.

M. Key Interlocks: Arranged to effect interlocking schemes indicated.
   1. Description: Dual radial campus feeders will be routed from the north station switchgear installed under this project to the south station switchgear installed under a future contract. The circuit breakers must be interlocked such that either the two north station feeder breakers or the two south station feeder breakers can be closed at the same time, preventing paralleling of the two stations through the distribution feeders.

N. Provisions for Future Key Interlocks: Mountings and hardware required for future installation of locks, where indicated.

O. Indicating lights shall be LED type or equivalent. On the front of each circuit breaker cubicle, provide lights to indicate the following:

   1. Circuit breaker closed, Red Lens.

   2. Circuit breaker open, Green Lens.

   3. Other indicators, White, Blue or Amber Lenses as indicated on the drawings.

P. Circuit breaker control switches shall be pistol grip with trip, normal after trip, normal after close, and close contacts.

## 2.7 COMPONENTS

A. Main Bus: Copper, silver plated at connection points; full length of switchgear.

B. Ground Bus: Copper, silver plated or copper, tin plated; minimum size one quarter (1/4) inch by two (2) inches; full length of switchgear.

C. Bus Insulation: Covered with flame-retardant insulation.

D. Instrument Transformers: Comply with IEEE C57.13.

   1. Potential Transformers: Secondary voltage rating of 120 V and NEMA accuracy class of 0.3 with burdens of W, X, and Y.

   2. Current Transformers: Burden and accuracy class suitable for connected relays, meters, and instruments.

E. Multifunction Digital-Metering Monitor:

   1. Acceptable Models:
      a. Main Breakers: Schneider Electric PowerLogic ION 9000T with small display screen.

b. Generator Breakers: Schneider Electric PowerLogic ION 9000T with small display screen.
c. All Other Breakers: Schneider Electric Power Logic CM4000T.

2. Provide quantity and location of meters as indicated on the Drawings. Meter shall be mounted so that the display is a maximum of 5 ft AFF.

3. Meters shall use TCP/IP over Ethernet for communication links.

4. Current transformer poles shall have shorting auxiliary contacts and all CT wiring shall be on shorting type terminal blocks.

5. If the meter does not have a meter serial number on the front of the display, then an engraved nameplate shall be installed below the meter displaying the meter serial number.

6. Provide "Certificate of Compliance and Calibration" for each meter, which provides test tracing back to (NIST).

7. Mounting: Display and control unit that is flush or semiflush mounted in instrument compartment door.

8. Breaker Monitoring Inputs: Coordinate power supply for the 52a/TOC/86 inputs into the meter with the available voltage ratings for the inputs into the meter. Utilize meter's 24VDC power supply.

F. Relays: Comply with IEEE C37.90, integrated digital type; with test blocks and plugs. Basis of design for relaying is Schweitzer Engineering Laboratories (SEL) with types and functionality as shown on the drawings.

1. Provide relay test switches for each relay with shorting test blocks for all CT circuits. Test switches shall be all black with clear covers.

2. Provide relay input/ output cards as required for all inputs, outputs, and communications as shown on the drawings. At minimum, a communication card that accepts dual Ethernet inputs, a fiber input, and an irgb input are required. All spare card slots shall be provided with cards that include 4 digital inputs and 4 digital outputs.

3. For SEL 751 relays, provide 5" touchscreen model.

4. Contractor shall be responsible for providing all relay settings files in electronic format. The Engineer will provide set points for overcurrent, synchronization, and differential only. The settings files provided by the Contractor shall include all required parameters for mapping inputs/ outputs, trip equations, LED displays, event recording, and all functions required for the sequence of operations such as but not limited to undervoltage and underfrequency.

G. Remote Racking Device: Provide capability for remote racking. Provide remote racking device and components. Provide two remote racking devices (one for Howard Hall and one for North Switching Station).

H. Provision for Future Devices Equip compartments with rails, mounting brackets, supports, necessary appurtenances, and bus connections.

I. Control Power Supply: DC battery system with ratings as shown on the drawings. The DC battery system shall contain fully redundant battery strings and chargers, each capable of carrying the full DC load of the switchgear system.

J. Control Wiring: Factory installed, complete with bundling, lacing, and protection; and complying with the following:

1. Flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.
2. Conductors sized according to NFPA 70 for duty required.

## 2.8 CONTROL BATTERY SYSTEM

A. System Requirements: Battery shall have number of cells and ampere-hour capacity based on an initial specific gravity of 1.210 at $25^0$C with electrolyte at normal level and minimum ambient temperature of $13^0$C. Cycle battery before shipment to guarantee rated capacity on installation. Arrange battery to operate ungrounded.

B. Battery: Valve regulated lead acid type with Absorbent Glass Mat (VRLA AGM). System batteries shall be suitable for service at an ambient temperature ranging from minus $18^0$C to $25^0$C. Limit variation of current output to 0.8 % for each degree below $25^0$C down to minus $8^0$C.

C. Rack: Six-step rack with electrical connections between battery cells and between rows of cells; include two flexible connectors with bolted-type terminals for output leads. The batteries shall be horizontally stacked within the rack.

D. Accessories:

1. Thermometers with specific-gravity correction scales.
2. Hydrometer syringes.
3. Set of socket wrenches and other tools required for battery maintenance.
4. Wall-mounting, nonmetallic storage rack fitted to store above items.
5. Set of cell numerals.

E. Charger: Static-type silicon rectifier equipped with automatic regulation and provision for manual and automatic adjustment of charging rate. Unit shall automatically maintain output voltage within 0.5 % from no load to rated charger output current, with ac input-

voltage variation of plus or minus 10 percent and input-frequency variation of plus or minus 3 Hz. Other features of charger include the following:

1. DC ammeter.
2. DC Voltmeter: Maximum error of 5% at full-charge voltage; operates with toggle switch to select between battery and charger voltages.
3. Ground Indication: Two appropriately labeled lights to indicate circuit ground, connected in series between negative and positive terminals, with midpoint junction connected to ground by normally open push-button contact.
4. Capacity: Sufficient to supply steady load, float-charge battery between 2.20 and 2.25 V per cell and equalizing charge at 2.33 V per cell.
5. Charging-Rate Switch: Manually operated switch provides for transferring to higher charging rate. Charger operates automatically after switch operation until manually reset.
6. AC power supply is 208 V or 480 V as indicated on the drawings, 60 Hz, subject to plus or minus 10 % variation in voltage and plus or minus 3-Hz variation in frequency. After loss of ac power supply for any interval, charger automatically resumes charging battery. Charger regulates rate of charge to prevent damage due to overload and to prevent fuses or circuit breakers from opening.
7. Protective Feature: Current-limiting device or circuit, which limits output current to rating of charger but does not disconnect charger from either battery or ac supply; to protect charger from damage due to overload, including short circuit on output terminals.
8. Electrical Filtering: Reduces charger's audible noise to less than 26 dB.

F. Eyewash Station: Provide self-contained eye wash station outside of battery room as shown on the drawings.

## 2.9 IDENTIFICATION

A. Materials: Refer to Division 26 Section "Identification for Electrical Systems." Identify units, devices, controls, and wiring.

B. Mimic Bus: Continuous mimic bus applied to front of switchgear, arranged in single-line diagram format, using symbols and lettered designations consistent with approved final mimic-bus diagram.

1. Mimic-bus segments coordinated with devices in switchgear sections to which applied, to produce a concise visual presentation of principal switchgear components and connections.
2. Medium: Painted graphics, as approved.
3. Color: Contrasting with factory-finish background; selected by Architect.

C. Each cubicle of the switchgear must have a yellow sign with black lettering stating: “CUSTOMER OWNED SWITCHGEAR”. The sign shall be a minimum of 5” wide by 3” high

and shall be placed on the door under the breaker operating control switch. The sign shall be placed in the same relative position on the revenue metering cubicles.

## 2.10 SOURCE QUALITY CONTROL

A. Factory Tests: Perform design and routine tests according to standards specified for components.
   1. The PLC programmer shall be available and present at the factory site during the full factory witness testing period so that any discovered issues or necessary modifications may be addressed at that time. The same PLC programmer shall be available during the complete site start-up and testing effort (see Part 3) and shall be present during the full site witness testing period so that any discovered issues or necessary modifications may be addressed at that time.
   2. Submit all test procedures for approval and notify the Project Manager thirty days prior to commencement of any tests. Testing shall be witnessed by the Owner, and/or their duly authorized representatives. Indicate the approximate duration of the tests.
   3. Provide four (4) copies of the factory test reports within two weeks of the completion of factory testing detailed herein.

B. Before shipment of equipment, perform the following tests and prepare test reports:

   1. Production tests on circuit breakers according to ANSI C37.09.
   2. Production tests on completed switchgear assembly according to IEEE C37.20.2.
   3. Include complete point-to-point check for all switchgear wiring.

C. Assemble switchgear and equipment in manufacturer's plant and perform the following:

   1. Functional tests of all relays, instruments, meters, and control devices by application of secondary three-phase voltage to voltage circuits and injection of current in current transformer secondary circuits.
   2. Functional test of all control and trip circuits. Connect test devices into circuits to simulate operation of controlled remote equipment such as circuit-breaker trip coils, close coils, and auxiliary contacts. Test proper operation of relay targets.

D. Prepare equipment for shipment and ship equipment to jobsite.

   1. Provide suitable crating, blocking, and supports so equipment will withstand expected domestic shipping and handling shocks and vibration.
   2. Weatherproof equipment for shipment. Close connection openings to prevent entrance of foreign material during shipment and storage.

E. Factory Tests: A complete test of the custom PLC logic and other special features including actual operation of all the breakers in the switchgear to demonstrate all possible conditions of operation. All procedures for system configuration shall be

demonstrated and testing shall include attempted operation of all breakers to verify proper interlocking.

1. Provide contactors as necessary to simulate interfacing PLC control of the 480V switchgear with the medium voltage switchgear. Refer to the Sequence of Operation Specification for requirements.

F. Owner will witness all required factory tests. Contractor to provide accommodations if more than 50 mi from site. Notify Owner at least 14 days before date of tests and indicate their approximate duration.

1. Attendance or non-attendance by the Owner and/or their duly authorized representatives at factory tests shall not relieve the manufacturer of responsibility to correct any defects or items of non-conformance with these specifications discovered during site testing.

2.11 FACTORY FINISHES

A. Finish: Manufacturer's standard color finish applied to equipment before shipping.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine elements and surfaces to receive switchgear for compliance with requirements for installation tolerances, required clearances, and other conditions affecting performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Anchor switchgear assembly to four (4) inch, channel-iron sill embedded in concrete baseand attach by bolting.

1. Sills: Select to suit switchgear; level and grout flush into concrete base.

2. Concrete Bases: Four (4) inches high, reinforced, with chamfered edges. Extend base no less than three (3) inches in all directions beyond the maximum dimensions of switchgear, unless otherwise indicated or unless required for seismic anchor support. Construct concrete bases according to Division 26 Section "Hangers and Supports for Electrical Systems."

B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchgear units and components.

## 3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."

B. Diagram and Instructions:

1. Frame under clear acrylic plastic on front of switchgear.

   a. Operating Instructions: Printed basic instructions for switchgear, including control and key-interlock sequences and emergency procedures.
   b. System Power Riser Diagrams: Depict power sources, feeders, distribution components, and major loads.

2. Storage for Maintenance: Include a rack or holder, near the operating instructions, for a copy of maintenance manual.

## 3.4 CONNECTIONS

A. Cable terminations at switchgear are specified in Division 26 Section "Medium-Voltage Cables."

B. Tighten bus joints, electrical connectors, and terminals according to manufacturer's published torque-tightening values.

C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Division 26 Sections "Low-Voltage Electrical Power Conductors and Cables" and "Medium-Voltage Cables."

E. Connect multifunction digital-metering monitor according to Division 26 Section “Electrical Power Monitoring.”

## 3.5 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Test insulation resistance for each switchgear bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following:

1. Inspect switchgear, wiring, components, connections, and equipment installation. Test and adjust components and equipment.
2. Assist in field testing of equipment.
3. Report results in writing. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

C. Testing Agency: Engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
   1. The Testing Agency shall be responsible for inputting the final relay protection set points provided by the Engineer in the field.

D. Perform the following field tests and inspections and prepare test reports:

   1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS. Certify compliance with test parameters. Perform NETA tests and inspections for each of the following NETA categories:

      a. Switchgear.
      b. Circuit breakers.
      c. Protective relays.
      d. Instrument transformers.
      e. Metering and instrumentation.
      f. Ground-fault systems.
      g. Battery systems.
      h. Surge arresters.
      i. Capacitors.
      j. SCADA and automation equipment.

E. Remove and replace malfunctioning units and retest as specified above.

F. Infrared Scanning: After Substantial Completion, but not more than sixty (60) days after Final Acceptance, perform infrared scan of each switchgear. Remove front and rear panels so joints and connections are accessible to portable scanner.

   1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchgear eleven (11) months after date of Substantial Completion.
   2. Instrument: Use an infrared-scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
   3. Record of Infrared Scanning: Prepare a certified report that identifies switchgear checked and that describes infrared-scanning results. Include notation of deficiencies detected, remedial action taken and observations after remedial action.

## 3.6 CLEANING

A. On completion of installation, inspect interior and exterior of switchgear. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair damaged finishes.

## 3.7 PROTECTION

A. Temporary Heating: Apply temporary heat to switchgear, according to manufacturer's written instructions, throughout periods when switchgear environment is not controlled for temperature and humidity within manufacturers stipulated service conditions.

## 3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain switchgear. Refer to Division 01 Section "Demonstration and Training."
   1. Include operation of remote racking device, control system operation, and generator starting and manual syncing.

END OF SECTION 261300

# SECTION 261301 – 4,160V MEDIUM-VOLTAGE SWITCHGEAR

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 26.

### 1.2 DESCRIPTION OF WORK

A. This section provides the specification for the Medium-Voltage Switchgear and related accessories that shall be furnished by the manufacturer.

### 1.3 DELIVERY

A. The supplier's shipping company shall verify all height, weight, and traffic limitations when considering pricing and actual delivery. The delivery at the site for the equipment unloading shall be scheduled for normal working hours of Monday through Friday (7:00am – 3:00pm). The actual delivery through the University of Maryland, Baltimore campus must be scheduled with the University to prevent travel through major campus activity days. The shipper shall consider that it may take up to 4 hours before the switchgear is lifted off the delivery truck and the truck is free to leave.

### 1.4 SUMMARY

A. This Section includes metal-clad, circuit-breaker switchgear with the following optional components, features, and accessories:

1. Copper, silver-plated main bus at connection points.
2. Communication modules.
3. Relays.
4. Surge arresters.
5. Provisions for future devices.
6. Control battery system.
7. Mimic bus.

### 1.5 DEFINITIONS

A. ATS: Acceptance Testing Specifications.

B. GFCI: Ground-Fault Circuit Interrupter.

1.6 SUBMITTALS

A. Provide compliance statement as described under the Quality Assurance section of this Specification.

B. Submittals:
   1. Product Data: For each type of switchgear and related equipment, include the following:

      a. Rated capacities, operating characteristics, furnished specialties, and accessories for individual circuit breakers.
      b. Time-current characteristic curves for overcurrent protective devices, including circuit-breaker relay trip devices.

   2. General arrangement drawings of switchgear and accessories complete with dimensions. Include plan view and section view drawings. Indicate required clearances and overall dimensions.
   3. Single line diagrams.
   4. Shop Drawings: For each type of switchgear and related equipment, include the following:

      a. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show method of field assembly and location and size of each field connection. Include the following:

         1) Tabulation of installed devices with features and ratings.
         2) Outline and general arrangement drawing showing dimensions, shipping sections, and weights of each assembled section.
         3) Drawing of cable termination compartments showing preferred locations for conduits and indicating space available for cable terminations.
         4) Floor plan drawing showing locations for anchor bolts and leveling channels.
         5) Current ratings of buses.
         6) Short-time and short-circuit ratings of switchgear assembly.
         7) Nameplate legends.
         8) Mimic-bus diagram.
         9) Metering provisions with approval by Owner.

      b. Wiring Diagrams: For each type of switchgear and related equipment, include the following:

1) Power, signal, and control wiring.
2) Three-line diagrams of current and future secondary circuits showing device terminal numbers and internal diagrams.
3) Schematic control diagrams.
4) Diagrams showing connections of component devices and equipment.
5) Schematic diagrams showing connections to remote devices including SCADA remote terminal unit.
6) Motor starter control system diagrams including the following:

a) Logic diagrams, written around the schematics included in the contract documents, showing inputs, outputs, and control functions used to control tripping and closing each motor contactor as indicated on the Drawings. A reference set of circuit breaker schematics, three line diagrams, and point to point wiring diagrams.

c. Circuit Breaker Control Schematics and Switchgear point to point wiring diagrams.

1) Control and Protective relay diagrams including the following:
   a) Instrument transformer ratios, accuracy class, transformer wiring connections, and polarities.
   b) Control wiring size and type.
   c) All external wiring connections for each protective relay.
2) All switchgear drawings prepared by the Equipment Vendor shall be submitted to the Engineer in AutoCAD format in addition to hard copy submittals. Electronic files to be submitted include:
   a) Circuit Breaker Control Schematics for each breaker cubical.
   b) Point to Point Wiring Diagrams for each switchgear cubical.
   c) Switchgear Three Line Diagrams.
   d) Switchgear Single Line Diagrams
3) Schematic diagrams showing connections to remote devices including SCADA remote terminal unit.

5. Coordination Drawings: Floor plans showing dimensioned layout, required working clearances, and required area above and around switchgear where piping and ducts are prohibited. Show switchgear layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Identify field measurements. Include layout of battery room.
6. Samples: Representative portion of mimic bus with specified finish. Manufacturer's color charts showing colors available for mimic bus.
7. Verification of compatibility with existing Trane Chillers and Adaptiview Control Panels.
8. Qualification Data: For testing agency.
9. Source quality-control test reports.

10. Field quality-control test reports.
11. Operation and Maintenance Data: For switchgear and switchgear components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
    a. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
    b. Time-current curves, including selectable ranges for each type of overcurrent protective device.

## 1.7 QUALITY ASSURANCE

A. Compliance Statement: The Manufacturer/Equipment Vendor shall include a Compliance Statement, listing each Specification Section, and Part 1, 2, and 3 Sub-Sections, stating, paragraph-by-paragraph, compliance with the Specification, each minor nonconformity that is within the intent of the Specification, and proposed nonconformities. Provide short description of minor nonconformities, and detailed explanation of other nonconformities.

B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

    1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

C. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7.

D. Source Limitations: Obtain each type of switchgear and associated components through one source from a single manufacturer.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

F. Comply with IEEE C2.

## 1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver in sections of lengths that can be moved past obstructions in delivery path as indicated.

B. Store switchgear indoors in clean dry space with uniform temperature to prevent condensation. Protect switchgear from exposure to dirt, fumes, water, corrosive substances, and physical damage.

## 1.9 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation at indicated ampere ratings for the following conditions:

1. Ambient temperature not exceeding $122^0$F
2. Altitude of 3300 feet above sea level.

B. Installation Pathway: Remove and replace building components and structures to provide pathway for moving switchgear into place.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchgear, including clearances between switchgear and adjacent surfaces and other items. Comply with indicated maximum dimensions.

D. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify Owner no fewer than 10 days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without Owner's written permission.

3. Outages to existing loads shall occur during off hours.

    a. If contractor elects to do outages or switchovers during normal hours then contractor shall submit a plan to be approved by the owner and provide temporary power at no additional cost.

## 1.10 COORDINATION

A. Coordinate layout and installation of switchgear and components with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required clearances for workspace and equipment access doors and panels.

B. Coordinate size and location of concrete bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.11 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: Two of each type and rating used. Include spares for future transformers, control power circuits, and fusible devices.
2. Indicating Lights: Two of each type installed.
3. Touchup Paint: One container of paint matching enclosure finish, each 0.5 pint.

B. Maintenance Tools: Furnish tools and miscellaneous items required for interrupter switchgear test, inspection, maintenance, and operation. Include the following:

1. Fuse-handling tool.
2. Ground cable, bare copper #4/0, of at least 10’-0” length with clamps at each end.
3. Linemen’s gloves with a minimum 13kV rating.
4. Extension rails, lifting device, transport or dockable dolly or mobile lift, and all other items necessary to remove circuit breaker from housing and transport to remote location.
5. Racking handle to move circuit breaker manually between connected and disconnected positions, and a secondary test coupler to permit testing of circuit breaker without removal from switchgear.
6. Spare fuse storage cabinet: with piano hinged doors and key lockable. Sized for above listed maintenance tools.

1.12 WARRANTY/GUARANTEE

A. See Division 26 Specification Section “Basic Electrical Requirements’ for warranty and guarantee requirements.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the manufacturers specified.

## 2.2 MANUFACTURED UNITS

A. Description: Factory assembled and tested, and complying with IEEE C37.20.1.

B. Ratings: Suitable for application in 3-phase, 60-Hz, solidly grounded-neutral system.

C. System Voltage: 13.2 kV nominal; 15 kV maximum.

D. Available Manufacturers:

1. Eaton Corporation; Cutler-Hammer Products.
2. ABB Control, Inc.
3. Rockwell Automation; Allen-Bradley Co.; Industrial Control Group.
4. Schneider Electric, Inc.

## 2.3 INCOMING SECTION

A. Primary Incoming Section: Close-coupled, enclosed, load break, air-interrupter or SF6 gas insulated primary switch.

1. Three pole, single throw, dead front, metal enclosed, with manual stored energy operator, with fuses, complying with IEEE C37.20.3.
2. Key interlocking system to prevent fuse access door from being opened unless switch is open. Lock cylinders shall use BEST access systems key cylinders with removable 7-pin cores. Spare keys shall be provided to UTHVS and shall permit the opening of the fuse compartment door with the switch closed.
3. Insulation: All medium voltage connections, bus bars and devices in switches shall be insulated. Insulated barriers shall not be allowed to come in contact with insulated conductors and shall maintain a 3 inch clearance. A minimum of 6 inch clearance shall be observed between insulated and uninsulated barriers from uninsulated conductors.
4. Phase Barriers: Located between blades of each phase, designed for easy removal, allows visual inspection of switch components when barrier is in place.
5. Window: Permits viewing switch-blade positions when door is closed. Air break primary switches shall have a 6 inch minimum break between contacts.
6. Switch contact status for gas insulated switches shall be derived from positive position sensing of the primary contacts and be visually inspectable with the switch energized.
7. The switch shall be constructed with the switch above the fuses. The switch blades shall pivot on the bottom (load side) of the switch. Provide bussing from the top of the switch for cable entrance from the bottom.
8. Accessory Set: Tools and miscellaneous items required for interrupter switchgear test, inspection, maintenance, and operation. Include fuse-handling tool as recommended by switchgear manufacturer.
9. Voltage: 15kV Nominal

10. Continuous-Current Rating: 600 A.
11. Short-Circuit Rating:

    a. 2-second symmetrical rating of 38-kA RMS.
    b. Fault close asymmetrical rating of 61 kA.

12. Fuses shall be E type clip style fuses sized as indicated on the drawings.
13. Switch handles shall face the front of the enclosure and shall have provisions for padlocks in both the open and closed positions.
14. The switches shall be capable of being operated with the operator staffing safely away from the front of the switch.
15. Front compartment doors shall be hinged and provisions for padlocks. Rear panels shall be bolted.
16. The switches shall be rated electrically and mechanically for a minimum of 1,000 load break operations.
17. The switches shall not have floor plates.
18. The switches shall be constructed to provide safe access to terminals without de-energizing the switch. Switches and bussing shall use porcelain insulators throughout the compartments.
19. Switch operating mechanisms which use chains are not permitted.
20. Unshielded 15kV cable shall be trained and properly supported to provide a minimum of 1 ½" inches to any grounded part.
21. Provide ground ball studs on all phase and ground buses.
22. All terminations shall be crimp style connections utilizing 2 hole long barrel lugs.

## 2.4 DRY-TYPE TRANSFORMER SECTION

A. Refer to Specification 261200 Medium-Voltage Transformers for requirements.

## 2.5 SWITCHGEAR

A. Comply with IEEE C37.20.3.

B. Nominal Interrupting-Capacity Class: 50kA.

C. Ratings: Comply with IEEE C37.04.

1. Main-Bus Rating: 1200 A, continuous.

D. Switchgear Assembly:

1. Switchgear enclosure, busbar assemblies, switches, metering, protection, and switchgear controls shall be factory assembled and tested, and shall have ratings as described in the paragraphs below, in accordance with the Standards listed in Part 1 of this Section.

E. Motor Starters:

1. Motor Starter isolating switch and contactor assemblies, including current limiting fuses, shall be of the component-to-component design without any interconnecting cables or flexible shunts. The isolating switch shall be easily removed from the front of the enclosure. Line and load cable shall be completely accessible from the front.
2. Motor starters shall be designed to accommodate a single compressor of a Trane model CVHF chiller.
3. The starters shall be across the line type to accommodate the following motor type:

    a. Induction Motor: As indicated on drawings.
    b. Before purchase contractor shall confirm chosen starter type is compatible with existing chiller and chiller control panel.

4. The following equipment shall be provided for each starter:
    a. Medium-Voltage Section:

        1) Isolated vertical line connectors.
        2) Three-pole isolating switch
        3) Current limiting power fuses. (Clip-in Type)
        4) Roll-out three-pole main vacuum contactor assembly
        5) Control circuit transformer
        6) Control circuit primary current limiting fuses
        7) Control circuit secondary fuse
        8) Run-test circuit
        9) Electrical interlocks
        10) Current transformers – sets for Metering, Protection and Chiller as indicated on the drawings.
        11) Load terminals

5. The low-voltage control compartment shall be isolated and barriered form the high-voltage area and mounted on a panel with a separate low-voltage access door. The low-voltage control components shall be accessible by sliding the panel out of the low-voltage control compartment. Interior of the control compartment shall be painted gloss white.
6. Each 5kV starter shall have cable termination area capable of accepting 2 sets of 500kcmil shielded cables per phase.
7. Each starter cell shall contain a vertical and horizontal low voltage wireway.
8. Enclosure shall be completely front accessible, allowing for free-standing, against a wall, or back-to-back mounting.

F. Motor Starter Main Isolation Switch:

1. Each starter shall contain an isolating switch which shall be an externally operated manual three-pole draw-out type, such that in the open position it completely grounds and isolates the starter from the line connectors with a mechanically driven isolating shutter leaving no exposed high-voltage components. The isolation switch shall be designed for a minimum of 10,000 operations.
2. Integral mechanical interlocks shall prevent entry into the high-voltage areas while the starter is energized and shall block accidental opening or closing of the isolating switch when the door is open or the contactor is closed.
3. The isolating switch handle shall have provisions for three (3) padlocks in the off position and one (1) padlock in the closed or on position.
4. The isolation switch shall be a 400A non-load break design.
5. The main door shall have a viewing window through which the operator can verify that the isolation switch is open.
6. The stationary primary contacts shall be silver-plated and recessed within insulating tubes. A steel shutter shall automatically cover the stationary primary disconnecting contacts when the starter is in the disconnected position or out of the cell. Provide rails to allow withdrawal of each starter and power factor correction capacitor for inspection and maintenance without the use of a separate lifting device.
7. A built-in test circuit shall be included to permit checking of the starter control and pilot circuit, with the high-voltage de-energized and isolated, and the contactor in its normal position or in the draw-out position. The control circuit shall be capable of being energized through a polarized plug connector from an external 115-volt supply while in the test mode.
8. The isolation switch shall be mechanically and electrically interlocked with the main vacuum contractor.

G. Motor Starter Power Fuses:

1. Current limiting power fuses shall be provided with special fatigue proof elements that allow the elements to absorb the expansions and contractions created by the heating and cooling associated with severe cycling with visible fuse condition indicators. The fuses shall incorporate special time/current characteristics for motor service allowing proper coordination with the contactor and overload relay for maximum motor protection. This coordination shall be such that under a low-fault condition the interrupting rating and drop-out time of the contactor shall be properly coordinated with all possible fuse sizes to eliminate contactor racing. The power fuses shall be vertically mounted permitting easy inspection and replacement without starter disassembly. Provide a fuse puller with each starter.

H. Vacuum Contactor:

1. The vacuum contactor shall be of roll-out and latched design, rated 400 amperes with single-break high-pressure type main contacts with weld-resistant alloy contact faces. The vacuum contactor contact wear shall be easily checked with the use of a “go/no-go” feeler gauge. Provide a feeler gauge with each contactor.

2. Mechanically-latched contactor shall be closed electrically from a remote CLOSE contact. Signal will be initiated from the Trane AdaptiView Panel.
3. An electrically-operated solenoid shall be supplied to trip the contact as indicated on the contract drawings.
4. The contactor shall be interlocked with the non-load break isolation switch to provide the following features:

    a. Prevent the isolating switch from being opened or closed when the contactor is in the closed position.
    b. Prevent opening of the medium voltage door when the isolating switch is in the closed position.
    c. Prevent closing of the isolation switch when the medium voltage door is open.

I. Low-Voltage Compartment and Wireway

1. Provide a 2 in x 4 in low voltage wireway across the top of the structures to allow a convenient method of interconnecting control wiring from one section to another.
2. Each motor controller shall have a separate, front accessible, low voltage control compartment. The compartment shall be completely isolated using metal barriers between the low voltage compartment and the medium voltage compartments. Access to the low voltage compartment shall be permitted when the starter is energized.
3. All remote low voltage cable shall be able to enter the low voltage control panel from the top or the bottom of the structure. Access shall be by means of removable entry plate.
4. Low-Voltage Compartment and Door shall include the following:

    a. Large Motor Protection Relay (MPR)
    b. Starter Interlock Relay
    c. Start Interlock Relay
    d. Aux Run Interlock Relay
    e. Additional Relays as indicated on the drawings.
    f. Control circuit terminal blocks.
    g. Microprocessor metering package

J. Test Accessories: Relay and meter test plugs.

K. Low-DC-Voltage Alarm: Switchgear shall have a monitor for dc control power voltage with a remote contact output and Factory set alarm value at 80% of full-charge voltage.

L. Grounding and Testing Device: Suitable for phasing out, testing, and grounding switchgear bus or feeder if device is installed in place of circuit breaker. Include the following:

1. Portable Grounding and Testing Device: Interchangeable with drawout-mounting, medium-voltage circuit breakers to provide interlocked electrical access to either bus or feeder; electrically operated.
2. System control cabinet permanently mounted near switchgear.
3. Portable Remote-Control Station: For grounding and testing device.
4. Control-Cabinet Coupler Cable: Of adequate length to connect device inserted in any switchgear cubicle and control cabinet.
5. Remote-Control Coupler Cable: Fifty (50) feet long to connect control cabinet and portable remote-control station.
6. Permanent Control Power Wiring: From control cabinet to power source.
7. Protective Cover: Fabricated of heavy-duty plastic and fitted to device.
8. Approval of Grounding and Testing Device System: Obtain approval of final system design from utility company and agency designated by Owner to handle future maintenance of medium-voltage switchgear.

M. Electrically operated remote circuit-breaker racking mechanism. Minimum of 2.

## 2.6 CONTROL SYSTEM

A. Refer to Power Monitoring and Control Specification. Control system shall be fully integrated with the 480V substation control system.

## 2.7 FABRICATION

A. Indoor Enclosure: Steel.

B. Finish: Manufacturer's standard gray finish over rust-inhibiting primer on phosphatizing-treated metal surfaces.

C. Main Bus: The main bus shall be copper with fluidized bed epoxy flame-retardant and track-resistant insulation. The bus supports between units shall be flame-retardant, track-resistant, cycloaliphatic epoxy. The switchgear shall be constructed so that all buses, bus supports, and connections shall withstand stresses that would be produced by currents equal to the momentary ratings of the circuit breakers. Insulated copper main bus shall be provided and have provisions for future extension. All bus joints shall be silver plated, to standard 0.1 mil thickness, bolted and insulated with easily installed boots. The bus shall be braced to withstand fault currents equal to or greater than the momentary rating of the switchgear. The temperature rise of the bus and connections shall be in accordance with ANSI standards and documented by design tests. All termination pads shall be equipped with grounding studs.

D. Ground Bus: Copper, minimum size 0.25 by 2 inches, full length of switchgear. The ground bus shall be extended out into the termination areas of each breaker compartment. Within the termination areas, the ground bus shall be sized to accommodate the

terminations for the cable shields and the 4/0 AWG (600V) feeder ground cable and equipped with grounding studs.

E. Bus Insulation: Covered with flame-retardant insulation.

F. Shutters: Metal shutters drop into place as each circuit breaker is racked out, and separate the busbars from the circuit breaker compartment with a grounded metal barrier when the circuit breaker is withdrawn.

G. Bus Transition Unit: Arranged to suit bus and adjacent units.

H. Incoming-Line Unit: Arranged to suit incoming line.

I. Outgoing Feeder Units: Arranged to suit distribution feeders.

J. Auxiliary Compartments: Arranged to suit house meters, relays, controls, and auxiliary equipment; isolated from medium-voltage components.

K. Doors: Hinged front doors, in accordance with ANSI construction, for each circuit breaker and metering & control compartment, with drop-bar to keep the door open during servicing, and fitted with padlocking attachment to prevent unauthorized access. Hinged rear doors, with three-point latching mechanism, drop-bar to keep the door open during servicing, and handle with lock. Provide 2 keys for each lock.

1. Provide a 4 inch minimum infra-red window in each rear door, positioned for optimal viewing of terminations and busbar/lug connections during thermographic surveying.

L. Control Wiring: Factory installed type SIS rated 600 volt, 90 degrees C, furnished with wire markers at each termination except where installation environments (temperature and chemical) require specialized insulation systems. Wires shall terminate on terminal blocks with marker strips numbered in agreement with detailed connection diagrams complete with bundling, lacing, and protection. Complying with the following:

1. Flexible stranded conductors for No. 12 AWG and larger.
2. Minimum size of #12 AWG.
3. All current transformer circuits shall be #10 AWG and wired through shorting type terminal blocks.
4. All control wiring shall be 600V SIS cable. The use of nylon is not acceptable.
5. All cables shall be terminated on terminal blocks using AMP or Burndy ring type solid un-insulted barrel terminations.
6. Each control wire shall be uniquely numbered at each end and at each termination point.
7. No more than two wires shall be connected at a single wiring terminal. Thread on wire nuts or split bolt connectors are not permitted. In-line control wire splices are not acceptable.

8. Terminal block shall be provided for all conductors requiring connection to circuits external to the specified equipment, where internal circuits cross shipping splits, and where equipment part replacement and maintenance will be facilitated.
9. Leave slack in bundled conductors at hinges and interconnections between shipping units. Wiring traversing hinges or other forms of flexible constructions shall be high stranded and shall traverse the area of bending normal to the plane of rotation so as to impart a twisting rather than a bending motion to the cable or wire bundle.
10. All control cables entering enclosures shall be secured by their jackets to the enclosure support to provide strain relief for the cable wire terminations.
11. All terminal blocks shall be removable screw or stud type. Compression type blocks are not acceptable.

M. Indicating lights shall be LED type or equivalent. On the front of each circuit breaker cubicle, provide lights to indicate the following:

1. Circuit breaker closed, Red Lens.
2. Circuit breaker open, Green Lens.
3. Other indicators, White, Blue or Amber Lenses as indicated on the drawings.

N. Circuit breaker control switches shall be pistol grip with trip, normal after trip, normal after close, and close contacts.

## 2.8 COMPONENTS

A. Instrument Transformers: Comply with IEEE C57.13.

1. Potential Transformers: Secondary voltage rating of 120 V and NEMA accuracy class of 0.3 with burdens of W, X, and Y.

2. Current Transformers: Burden and accuracy class suitable for connected relays, meters, and instruments.

a. Current Transformers for Differential Bus and Line Protection: Provide ANSI C200 accuracy class. All differential protection CTs shall have identical model numbers from the same manufacturer, and shall have identical ratios.

B. Metering:

1. Acceptable Models:

a. Chiller Feeders: Schneider Electric PM8240.

2. Refer to 260913 Electrical Power Monitoring and Control specification for detailed requirements for meters.

3. Provide quantity and location of meters as indicated on the Drawings. Meter shall be mounted so that the display is a maximum of 5 ft AFF.
4. Meters shall use TCP/IP over Ethernet for communication links. Daisy chain meters together and report load data back to the Howard Hall Metering Network Switch.
5. Current transformer poles shall have shorting auxiliary contacts and all CT wiring shall be on shorting type terminal blocks.
6. If the meter does not have a meter serial number on the front of the display, then an engraved nameplate shall be installed below the meter displaying the meter serial number.
7. Provide "Certificate of Compliance and Calibration" for each meter, which provides test tracing back to (NIST).
8. Mounting: Display and control unit that is flush or semiflush mounted in instrument compartment door.
9. Warranty Terms for Meters:
    a. The Equipment Vendor shall guarantee for twenty four (24) months from equipment startup or thirty (30) months from date of shipment, whichever occurs first, that the equipment shall be free from defects in design, workmanship or materials.
    b. In the event a component fails to perform as specified or is proven defective in service during the warranty period, the Contractor shall promptly repair or replace the defective part at no cost to the University.
10. Meters and associated CT's shall be revenue grade.
11. Meter inputs shall consist of 2 PT inputs and 3 CT inputs.

C. Relays: Comply with IEEE C37.90, integrated digital type; with test blocks and plugs.

1. Provide relay test switches for each relay with shorting test blocks for all CT circuits.
2. Motor Starter Protective Relays:

    a. The chiller motors will be monitored and protected by the AdaptiView control panel. The panel will monitor motor RTD inputs and have its own protection settings. The panel will have complete control of the starter for start/stop/trip functions. The MPR shall be provided for backup motor protection and feeder protection. The settings of the MPR will be set to coordinate with the chiller controls.
    b. Provide a definite purpose microprocessor-based Motor Protective Relay (MPR) in each starter, as indicated on the drawings for protection, control and monitoring of the motors. The MPR shall meet UL 1053 CUL and CSA standards.
    c. The true RMS current into the motor shall be constantly monitored, and by means of a protective algorithm, separated into positive and negative sequence components. These components shall be used to determine the heating effects on the stator and rotor of the motor to provide maximum

motor protection utilization. The MPR shall provide the following protective functions:

1) Motor running time overcurrent protection
2) Adjustable instantaneous overcurrent protection with adjustable start delay in one-cycle increments
3) Adjustable current unbalance protection (IEEE Device 46b - adjustable in percent unbalance)
4) Rotor protection
5) Underload trip with start and run time delays (IEEE Device 37/2)
6) Jam trip with start and run time delays
7) Zero sequence ground fault protection (Residual ground fault protection 50/51N) with adjustable start delay and run delay in one-cycle increments.

d. Only the following settings shall be needed to define the motor thermal protection curve.

1) Motor full load amperes (FLA)
2) Locked rotor current in percent of FLA
3) Locked rotor stall time in seconds
4) Ultimate trip current based on motor service factor

e. The following control functions shall be provided by internal solid-state based timers or relays.

1) Incomplete sequence delay (IEEE Device 2/19)
2) Limitation on number of starts per time period in minutes (IEEE Device 66)
3) Anti-backspin time delay (IEEE 2)
4) Programmable transition relay based on current and/or time.
5) Time between starts
6) Number of cold starts

f. The MPR shall have a real time clock for time tagging of events, operations, and history. The relay shall have quick and easy access to monitored values, view settings, motor history and motor log records. The relay shall monitor and display the following:

1) Motor Currents: Average current (lave), individual phase and ground current in primary amperes and percent of full load and percent phase unbalance
2) Motor: Percent I2t (thermal accumulation), time until next start can occur, remaining number of starts, and time left on oldest start.

g. The MPR shall be capable of accommodating external current transformers with ranges of as shown on the drawings. Where ground fault protection is specified, it shall be from an independent measuring circuit that utilizes residual scheme utilizing the three-phase current transformers (50/51N).

h. Two user programmable discrete inputs shall be provided for external control or trip functions. Programmable input functions shall be included for shut down based on external contacts for incomplete sequence of operation and remote trip, and differential trip.

i. The unit shall draw its power from a separate source of 125VDC as shown on the drawings.

j. The device shall have separate Form C (NO/NC) Trip, two programmable Form C (NO/NC) Alarm and Auxiliary contacts. All contacts shall have ratings of 10-amperes at 115/240-volt AC or 30-volt DC resistive. The alarm and auxiliary relay output contacts shall be programmable to operate from any internal protection function or from a discrete input signal such as differential trip or remote trip. All contacts shall be programmable to function in fail safe operation. The device shall be capable of providing a 4-20mA output signal proportional to one of the following user selectable parameters:

    1) Average of the three-phase currents
    2) I2t level

k. The relay shall be capable of monitoring electrical current, receiving commands from remote source either by contact closures or digital data, giving commands by means of contact closure to the motor starters and other devices under its control. The MPR shall be capable of displaying information by alphanumeric display to the operator or by digital communication signals to a remote location.

    1) The combination relay and operator panel shall be mounted on the door of the starter. Specific data entry to suit the actual motor application shall be programmed into the device by means of the operator panel pushbuttons.
    2) Entered data shall be stored in non-volatile memory so as not to require battery back up. Non-volatile memory shall be capable of storing all set-up information even after power failure, all monitored information at the time of a trip, and cause of trip even after power failure. Access to all programmed set points shall be restricted by means of a secured and sealed access cover.
    3) Alphanumeric display shall read out (in English) complete description of all protective functions e.g., “instantaneous overcurrent” and all monitored and programmable data.
    4) The MPR shall be user selectable as to being programmable while the motor is running or require a motor shut-down for programming. If

configured for programming while the motor is running, the protection shall stay active while programming based on previous settings. Upon the user exiting the programming mode, the new settings shall take effect.

l. The MPR shall provide the following data logging and display capability for history including the date and time from when the history was last reset and counting began. The history shall include:

1) Re-settable motor history for operational counter, runtime, highest starting and running currents, highest percent phase unbalance, maximum winding, bearing and load RTD temperature.
2) Re-settable Trip history for number of trips for ground faults, overloads, instantaneous overcurrent, JAM, underload, phase unbalance, phase reversal, incomplete sequence, remote differential, communication, starts exceeded, time between starts, and transition.
3) Re-settable Alarm history for number of alarms, for ground faults, overloads, JAM, underload, phase unbalance, starts exceeded.
4) A permanent history record which cannot be reset shall include total trips run time and operations count.
5) A log book including a chronological list of events or operations as detected by the MPR, such as, starts, stops, setting change, emergency override, trips, alarms or changes in the state of discrete inputs.
6) An event log providing detailed information on trips and alarms including phase and ground currents, percent phase unbalance and cause of trip or alarm.
7) A start log providing information on the four most recent starts including maximum phase, and ground starting current, maximum percent unbalance, time from start to transition, current at transition, and time from start to run or trip.

m. The MPR shall be provided in a quick release draw-out case. The MPR shall have a user programmable armed/disarmed feature with alarm indication. The disarmed mode shall permit relay installation while the motor is running with the trip outputs blocked. The drawout case shall have a spare self-shorting contact to allow for continuous motor running or relay remove alarm functions.

1) Make provisions for an addressable communications card capable of changing set points, transmitting all data, including trip/alarm data, a starting profile of the average phase current for the two most recent starts, all over at two-wire area network to a central computer for storage and/or printout.

D. Surge Arresters: Distribution class, metal-oxide-varistor type. Comply with NEMA LA 1.

1. Install in cable termination compartments in each phase of circuit.
2. Coordinate rating with circuit voltage.

E. Provision for Future Devices Equip compartments with rails, mounting brackets, supports, necessary appurtenances, and bus connections.

F. Control Power Supply: Control power transformer supplies 120-V control circuits through secondary disconnect devices. Include the following features:

1. Dry-type transformers, in separate compartments for units larger than 3 kVA, including primary and secondary fuses.

G. Control Power Fuses: Primary and secondary fuses provide current-limiting and overload protection.

## 2.9 IDENTIFICATION

A. Materials: Refer to Division 26 Section "Identification for Electrical Systems." Identify units, devices, controls, and wiring.

B. Mimic Bus: Continuous mimic bus applied to front of switchgear, arranged in single-line diagram format, using symbols and lettered designations consistent with approved final mimic-bus diagram.

1. Mimic-bus segments coordinated with devices in switchgear sections to which applied, to produce a concise visual presentation of principal switchgear components and connections.
2. Medium: Painted graphics, as approved.
3. Color: Contrasting with factory-finish background; selected by Architect.

C. Compartment Nameplates: Engraved, laminated-plastic or metal nameplate for each compartment, mounted with corrosion-resistant screws.

D. The Equipment Vendor shall be responsible for identifying all controls and wiring installed at the factory.

1. Each control wire terminal shall be identified with a unique number. Each control wire shall be identified on each end with a number matching the switchgear terminal number.
2. Devices shall be labeled inside the cabinets with the ANSI device number and the circuit number. Labels shall be self-adhesive, engraved, laminated, acrylic or melamine label with white letters on a black background. Minimum letter height shall be 3/8 inch.

2.10 SOURCE QUALITY CONTROL

A. Before shipment of equipment, perform the following tests and prepare test reports:

1. Production tests on circuit breakers according to ANSI C37.09.
2. Production tests on completed switchgear assembly according to IEEE C37.20.2.

B. Assemble switchgear and equipment in manufacturer's plant and perform the following:

1. Functional tests of all relays, instruments, meters, and control devices by application of secondary three-phase voltage to voltage circuits and injection of current in current transformer secondary circuits.
2. Functional test of all control and trip circuits. Connect test devices into circuits to simulate operation of controlled remote equipment such as circuit-breaker trip coils, close coils, and auxiliary contacts. Test proper operation of relay targets.

C. Prepare equipment for shipment and ship equipment to jobsite.

1. Provide suitable crating, blocking, and supports so equipment will withstand expected domestic shipping and handling shocks and vibration.
2. Weatherproof equipment for shipment. Close connection openings to prevent entrance of foreign material during shipment and storage.

D. Owner will witness all required factory tests. Contractor to provide accommodations if more than 50 mi from site. Notify Owner at least 14 days before date of tests and indicate their approximate duration.

1. Attendance or non-attendance by the Owner and/or their duly authorized representatives at factory tests shall not relieve the manufacturer of responsibility to correct any defects or items of non-conformance with these specifications discovered during site testing.

2.11 FACTORY FINISHES

A. Finish: Manufacturer's standard color finish applied to equipment before shipping.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine elements and surfaces to receive switchgear for compliance with requirements for installation tolerances, required clearances, and other conditions affecting performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.2 INSTALLATION

A. Anchor switchgear assembly to four (4) inch, channel-iron sill embedded in concrete base and attach by bolting.

1. Sills: Select to suit switchgear; level and grout flush into concrete base.
2. Concrete Bases: Four (4) inches high, reinforced, with chamfered edges. Extend base no less than three (3) inches in all directions beyond the maximum dimensions of switchgear, unless otherwise indicated or unless required for seismic anchor support. Construct concrete bases according to Division 26 Section "Hangers and Supports for Electrical Systems."

B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchgear units and components.

## 3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."

B. Diagram and Instructions:

1. Frame under clear acrylic plastic on front of switchgear.

a. Operating Instructions: Printed basic instructions for switchgear, including control and key-interlock sequences and emergency procedures.
b. System Power Riser Diagrams: Depict power sources, feeders, distribution components, and major loads.

2. Storage for Maintenance: Include a rack or holder, near the operating instructions, for a copy of maintenance manual.

## 3.4 CONNECTIONS

A. Cable terminations at switchgear are specified in Division 26 Section "Medium-Voltage Cables."

B. Tighten bus joints, electrical connectors, and terminals according to manufacturer's published torque-tightening values.

C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Division 26 Sections "Low-Voltage Electrical Power Conductors and Cables" and "Medium-Voltage Cables."

E. Connect multifunction digital-metering monitor according to Division 26 Section "Electrical Power Monitoring."

## 3.5 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Test insulation resistance for each switchgear bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following:

1. Inspect switchgear, wiring, components, connections, and equipment installation. Test and adjust components and equipment.
2. Assist in field testing of equipment.
3. Report results in writing. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

C. Testing Agency: Engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

D. Perform the following field tests and inspections and prepare test reports:

1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS. Certify compliance with test parameters. Perform NETA tests and inspections for each of the following NETA categories:

a. Switchgear.
b. Circuit breakers.
c. Protective relays.
d. Instrument transformers.
e. Metering and instrumentation.
f. Ground-fault systems.
g. Battery systems.
h. Surge arresters.
i. Capacitors.
j. SCADA and automation equipment.

E. Remove and replace malfunctioning units and retest as specified above.

F. Infrared Scanning: After Substantial Completion, but not more than sixty (60) days after Final Acceptance, perform infrared scan of each switchgear. Remove front and rear panels so joints and connections are accessible to portable scanner.

1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchgear eleven (11) months after date of Substantial Completion.
2. Instrument: Use an infrared-scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
3. Record of Infrared Scanning: Prepare a certified report that identifies switchgear checked and that describes infrared-scanning results. Include notation of deficiencies detected, remedial action taken and observations after remedial action.

## 3.6 CLEANING

A. On completion of installation, inspect interior and exterior of switchgear. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair damaged finishes.

## 3.7 PROTECTION

A. Temporary Heating: Apply temporary heat to switchgear, according to manufacturer's written instructions, throughout periods when switchgear environment is not controlled for temperature and humidity within manufacturers stipulated service conditions.

## 3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain switchgear. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 261300

# SECTION 261302 - SEQUENCE OF OPERATION FOR ELECRICAL EQUIPMENT

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

B. Refer to section 262313 Switchgear Controls and Automation for description of control system requirements and for Generator Startup Sequences.

### 1.2 SUMMARY

A. This Section includes control sequences and acceptance testing criteria for the electrical systems, which are composed of the following subsystems (as identified on the single-line diagrams):

1. North Switching Station
2. Future South Switching Station
3. Howard Hall 15kV Switchgear
4. Howard Hall Generator Paralleling Switchgear
5. Peaking Plant Paralleling Switchgear
6. Howard Hall 480V Switchgear
7. Bressler Research Building 480V Switchgear

B. Related Sections include the following:

1. Section 261116 “Secondary Unit Substations”
2. Section 261300 "Medium Voltage Switchgear"

3. Section 262313 “Switchgear Controls and Automation”

4. Section 263213 “Engine Generators”

C. System Description: The following sequence of operations shall be implemented and designed by the Power System Integrator in conjunction with the Medium Voltage Switchgear manufacturer via PLC based control and HMI screens. Refer to specification 262313 “Switchgear Controls and Automation” for control system and Power System Integrator requirements. In general, the control system shall accommodate the following functionality:

1. Automatic source transfer both for loss of utility and for individual bus or breaker failure.

2. Remote operation and monitoring of all circuit breakers. The circuit breaker operation will only be included as part of the sequence of operations and not as a manual digital pushbutton for user operation.

3. Engine control including:

a. Engine Start, Stop, Control, and Paralleling

D. Generator Interface: The control system shall fully integrate with the new Peaking Plant generator controllers and existing HSF3 switchgear control system.

1. Contractor Requirements:

a. Procure the services of GE to review the existing HSFIII GE Control System, review the existing sequence of operations, and perform all modifications necessary for integrating with the new automation system.

b. Coordinate all system modifications at HSFIII and the Peaking Plant to maintain control power at the Peaking Plant. Control power and wetting current at the Peaking Plant is provided by HSFIII.

2. Control System Integrator Requirements:

a. Integrate the existing GE Control System to the new automation system to receive HSFIII generator start/stop run statuses. This start/stop signal status shall be utilized by the new automation system as part of the system status check to the health of normal power available at HSFIII and the North Switching Station to determine automated breaker operations. HSFIII shall always have priority with the Peaking Plant generation and the Peaking Plant generators shall provide automatic standby power to HSFIII no matter the health of the normal Campus power source.

E. Future Equipment: This system shall be designed for integration of future South Switching Station. In addition, the system shall be expandable to include future generators and future 15kV and 480V building switchgear/substations.

1.3 DEFINITIONS AND ABBREVIATIONS

A. CB: Circuit Breaker

B. HMI: Human Machine Interface.

C. Loss of Voltage: Voltage level below an adjustable minimum level (50% to 100% Nominal Voltage) for an adjustable time period.

D. MOC: Mechanism Operated Contacts used to indicate circuit breaker position. MOC-a = contact open when breaker open, MOC-b = contact closed when breaker open.

E. Normal Power: Served by the utility source, but with standby generator backup.

F. Operator: the control system user.

G. Overvoltage: Voltage level above an adjustable minimum level (100% to 120% Nominal Voltage) for an adjustable time period.

H. PLC: Programmable Logic Controller

I. PT: Potential Transformer

J. Source Switching Station: The Switching Station that is currently aligned to feed the Howard Hall 15kV Switchgear. Either the North or South Switching Station.

K. System Control Screen: The control screen currently being accessed by the Operator, either an HMI screen at the switchgear, or a PC screen in the Central Plant control room.

L. Stable Voltage: Voltage level above an adjustable minimum level for an adjustable time period.

M. Switchgear Control System: The system of PLC's, input/output devices, communication devices, etc. used to control the 13.8kV switchgear and generators.

N. TOC: Truck Operated Contacts used to indicate breaker racked-in status. TOC-a contact closed when breaker is racked in, TOC-b = contact open when breaker is racked in.

O. Breaker Designations: refers to position of circuit breakers:

1. North Switching Station, Bus A
    a. NMA: Main breaker, Bus A
    b. N1A: Campus Feeder 1A
    c. N2A: Campus Feeder 2A
    d. N3A: Campus Feeder 3A
    e. N4A: Campus Feeder 4A
    f. N5A: Campus Feeder 5A
    g. N6A: Campus Feeder 6A
    h. N7A: Campus Feeder 7A (Future)
    i. NTA: Tie breaker to Bus NB
2. North Switching Station, Bus B
    a. NMB: Main breaker, Bus B
    b. N1B: Campus Feeder 1B
    c. N2B: Campus Feeder 2B
    d. N3B: Campus Feeder 3B
    e. N4B: Campus Feeder 4B
    f. N5B: Campus Feeder 5B
    g. N6B: Campus Feeder 6B
    h. N7B: Campus Feeder 7B (Future)
    i. NTB: Tie breaker to Bus NC

3. North Switching Station, Bus C
    a. NMC: Main breaker, Bus C
    b. N1C: Campus Feeder 1C
    c. N2C: Campus Feeder 2C
    d. N3C: Campus Feeder 3C
    e. N4C: Campus Feeder 4C
    f. N5C: Campus Feeder 5C (Future)
    g. N6C: Campus Feeder 6C (Future)
    h. N7C: Campus Feeder 7C (Future)
    i. NTC: Tie breaker to Bus ND
4. North Switching Station, Bus D
    a. NMD: Main breaker, Bus D
    b. N1D: Campus Feeder 1D
    c. N2D: Campus Feeder 2D
    d. N3D: Campus Feeder 3D
    e. N4D: Campus Feeder 4D
    f. N5D: Campus Feeder 5D (Future)
    g. N6D: Campus Feeder 6D (Future)
    h. N7D: Campus Feeder 7D (Future)
    i. NTD: Tie breaker to Bus NA
5. South Switching Station, Bus A (Future)
    a. SMA: Main breaker, Bus A
    b. S1A: Campus Feeder 1A
    c. S2A: Campus Feeder 2A
    d. S3A: Campus Feeder 3A

e. S4A: Campus Feeder 4A

f. S5A: Campus Feeder 5A

g. S6A: Campus Feeder 6A

h. S7A: Campus Feeder 7A

i. STA: Tie breaker to Bus SB

6. South Switching Station, Bus B (Future)

a. SMB: Main breaker, Bus B

b. S1B: Campus Feeder 1B

c. S2B: Campus Feeder 2B

d. S3B: Campus Feeder 3B

e. S4B: Campus Feeder 4B

f. S5B: Campus Feeder 5B

g. S6B: Campus Feeder 6B

h. S7B: Campus Feeder 7B

i. STB: Tie breaker to Bus SC

7. South Switching Station, Bus C (Future)

a. SMC: Main breaker, Bus C

b. S1C: Campus Feeder 1C

c. S2C: Campus Feeder 2C

d. S3C: Campus Feeder 3C

e. S4C: Campus Feeder 4C

f. S5C: Campus Feeder 5C

g. S6C: Campus Feeder 6C

h. S7C: Campus Feeder 7C

i. STC: Tie breaker to Bus SD

8. South Switching Station, Bus D (Future)
    a. SMD: Main breaker, Bus D
    b. S1D: Campus Feeder 1D
    c. S2D: Campus Feeder 2D
    d. S3D: Campus Feeder 3D
    e. S4D: Campus Feeder 4D
    f. S5D: Campus Feeder 5D
    g. S6D: Campus Feeder 6D
    h. S7D: Campus Feeder 7D
    i. STD: Tie breaker to Bus SA
9. Howard Hall 15kV Switchgear
    a. HNA: Main Breaker, North Switching Station, Bus A
    b. HNB: Main Breaker, North Switching Station, Bus B
    c. HSA: Main Breaker, South Switching Station, Bus A
    d. HSB: Main Breaker, South Switching Station, Bus B
    e. G1: Generator Paralleling Switchgear Feeder, Bus 1
    f. B1: Bressler Research Building Substation 1 Feeder
    g. B5: Bressler Research Building Substation 5 Feeder
    h. HA: Howard Hall 480V Switchgear, Substation A Feeder
    i. HT: Bus Tie Breaker
    j. HB: Howard Hall 480V Switchgear, Substation B Feeder
    k. B2: Bressler Research Building Substation 2 Feeder
    l. B6: Bressler Research Building Substation 6 Feeder
    m. B8: Bressler Research Building Substation 8 Feeder
    n. G2: Generator Paralleling Switchgear Feeder, Bus 2

10. Howard Hall Generator Paralleling Switchgear
    a. MG1: Main Breaker, HH 15kV Switchgear, Bus A
    b. MG2: Main Breaker, HH 15kV Switchgear, Bus B
    c. SB-G1: 1100kW Generator
    d. SB-G2: 1500kW Generator
    e. SB-G3: Future Generator
    f. SB-G4: Future Generator
    g. SB-G5: Future Generator
    h. SB-G6: Future Generator
    i. SB-G7: Peaking Plant Bus A
    j. SB-G8: Peaking Plant Bus B
    k. GT: Bus Tie Breaker
11. Peaking Plant Paralleling Switchgear
    a. A-F1: Switchgear E/NG5B1 Feeder
    b. A-F2: DP-1 Feeder
    c. A-F3: Howard Hall Generator Paralleling Switchgear Bus 1 Feeder
    d. A-F4: Future Feeder
    e. B-F1: Switchgear E/NG5B1 Feeder
    f. B-F2: Future Feeder
    g. B-F3: Howard Hall Generator Paralleling Switchgear Bus 2 Feeder
    h. B-F4: Future Feeder
    i. A-G1: 2000kW Gas Generator No. 1
    j. B-G2: 2000kW Gas Generator No. 2
    k. B-G3: 2000kW Gas Generator No. 3
    l. A-G4: Future Generator

1.4 Normal Operating conditions

1. North Switching Station Breaker

| **North Switching Station Switchgear** | | |
|---|---|---|
| Breaker Designation | NO | NC |
| NMA | | X |
| N1A | | X |
| N2A | | X |
| N3A | | X |
| N4A | | X |
| N5A | | X |
| N6A | | X |
| NTA | | X |
| Note: The distribution breakers will be Kirk-Key interlocked with the South Switching Station Distribution breakers. Only one source can supply the load at a time from the North or South Switching Station.<br><br>Note: Breakers in SWGR NB, NC, and ND have the same naming format but end with their respective letter instead of A. | | |

2. Howard Hall Main 15KV Switchgear.

| **Howard Hall 15KV Switchgear** | | |
|---|---|---|
| Breaker Designation | NO | NC |
| HNA | | X |
| HNB | | X |
| HSA | X | |

| | | |
|---|---|---|
| HSB | X | |
| G2 | | X |
| SPARE | X | |
| B5 | | X |
| B1 | | X |
| HA | | X |
| HT(TIE) | X | |
| HB | | X |
| B2 | | X |
| B6 | | X |
| B8 | | X |
| G1 | | X |

3. Howard Hall Generator Switchgear

| **Howard Hall 15 KV Generator Switchgear** | | |
|---|---|---|
| Breaker Designation | NO | NC |
| MG1 | | X |
| SBG1 | X | |
| FUT-SBG3 | X | |
| FUT-SBG5 | X | |
| SBG7 | | X |
| GT(TIE) | | X |
| SBG2 | X | |
| FUT-SBG4 | X | |

| | | |
|---|---|---|
| FUT-SBG6 | X | |
| SBG8 | | X |
| MG2 | | X |

4. 15KV Peaking Plant

| **Peaking Plant 15KV Switchgear** | | |
|---|---|---|
| Breaker Designation | NO | NC |
| A-G4 (EQUIPPED SPACE) | | |
| A-G1 | X | |
| A-F1 | | X |
| A-F2 | | X |
| A-F3 | X | |
| A-F4 (EQUIPPED SPACE) | | |
| T-1 | X | |
| B-F4 (EQUIPPED SPACE) | | |
| B-F3 | X | |
| B-F2 | X | |
| B-F1 | | X |
| B-G2 | X | |
| B-G3 | X | |

1.5 NORTH SWITCHING STATION PROCEDURES

A. Loss of Single Utility Source (Loss of Source to Bus A, B, C, or D)

1. When the utility voltage or frequency falls out of tolerance, as detected by the PLC from the line PTs on the Main Circuit Breaker CB MN(X), the Utility Failure timer in the PLC starts. When this timer expires, Main Circuit Breaker CB MN(X) Opens.

2. Refer to Section 1.4 for initial Bus and Circuit Breaker conditions.

3. Sequence: Utility out of tolerance.

    a. Utility Failure timer starts.

        1) If the utility returns before timer expires, system remains in initial state. Timer will be adjustable and initially set at 3 seconds.

    b. Utility Failure timer expires. Send an alarm to the control system indicating loss of single source.

    c. Open Breaker MN(X).

        1) If MN(X) fails to open: Open the two tie breakers that are closed in on that bus to isolate the Bus N(X).

    d. No further steps, the Bus will be fed through the ring bus and tie breakers.

4. Final Bus and Circuit Breaker Conditions:

    a. MN(X): Open

    b. All other Main Breakers: Closed

    c. NTA, NTB, NTC, NTD: Closed

    d. All feeder breakers closed

    e. Generators are Offline

B. Return of Utility during Loss of Single Source Event

1. When the utility voltage and frequency return within tolerance, the Utility Stable timer in the PLC starts if the Return Control switch is in Auto. When the timer expires, the Utility Breaker will Close back in.

2. Refer to Section 1.5.A for initial Bus and Circuit Breaker conditions.

3. Sequence: Utility is within tolerance as monitored from the Line PTs at MN(X).

    a. Utility Stable timer starts.

1) If utility is lost before timer expires, system remains with MN(X) open.

b. Utility Stable timer expires.

c. Main Breaker MN(X) Closes:

1) If circuit breaker MN(X) fails to close, system remains as is.

4. Refer to Section 1.04 for final Bus and Circuit Breaker conditions.

C. Loss of Multiple Utility Sources

1. When the utility voltage or frequency falls out of tolerance, as detected by the PLC from the line PTs on Multiple Main Circuit Breakers (MNA, MNB, MNC, or MND), the Utility Failure timer in the PLC starts. When this timer expires, the Main Circuit Breakers with loss of voltage Open.

2. Refer to Section 1.4 for initial Bus and Circuit Breaker conditions.

3. Sequence: Utility out of tolerance.

a. Utility Failure timer starts.

1) If the utility returns before timer expires, system remains in initial state. Timer will be adjustable and initially set at 3 seconds.

b. Utility Failure timer expires. Send an alarm to the control system indicating loss of sources. The control system shall monitor the load that is on the utility buses.

1) If the load on the North Switching Station is greater than the capacity of the remaining Utility Feeders (9MVA each) then the system shall initiate a load shed sequence. The control system shall open feeder breakers in reverse priority order. Refer to Section 1.12.B.2 for breaker priority list. Initiate an alarm that N+1 redundancy has been lost. Proceed with the Sequence.

2) If the load on the North Switching Station is less than the capacity of the remaining Utility Feeders (9MVA each), send an alarm to the control system that N+1 redundancy has been lost. Proceed with the sequence.

c. Open Utility Breakers with loss of voltage.

1) If MN(X) fails to open: Open the two tie breakers that are closed in on that bus to isolate the Bus N(X).

d. No further steps, the Bus will be fed through the ring bus and tie breakers.

4. Final Bus and Circuit Breaker Conditions:

    a. MN(X) (Loss of Voltage): Open

    b. All other Main Breakers: Closed

    c. NTA, NTB, NTC, NTD: Closed

    d. All feeder breakers closed

    e. Generators are Offline

D. Complete Loss of Utility (Buses A-D)

1. When the utility voltage or frequency falls out of tolerance, as detected by the PLC from the line PTs on Multiple Main Circuit Breakers (MNA, MNB, MNC, and MND), the Utility Failure timer in the PLC starts. When this timer expires, the Main Circuit Breakers MNA, MNB, MNC, and MND Open. System Generators Start.

2. Refer to Section 1.4 for initial Bus and Circuit Breaker conditions.

3. Sequence: Utility out of tolerance.

    a. Utility Failure timer starts.

        1) If the utility returns before timer expires, system remains in initial state. Timer will be adjustable and initially set at 3 seconds.

    b. Utility Failure timer expires. Send an alarm to the control system indicating loss of North Switching Station Power

    c. Open Utility Breakers MNA, MNB, MNC, and MND and all Non-Priority 1 Breakers on the North Switching Station. Initiate an Alarm

        1) If MN(X) fails to open: Open the two tie breakers that are closed in on that bus to isolate the Bus N(X).

    d. If Howard Hall is aligned to the North Switching Station, Proceed to Section 1.7.F – Loss of Source (X)A and (X)B (Power is Not available at Source Switching Station).

    e. If Howard Hall is aligned to the South Switching Station, initiate an alarm.

E. Return of Utility Sources (A-D)

1. Refer to Section 1.9.B – Return of Utility Source

## 1.6 SOUTH SWITCHING STATION PROCEDURES

A. Loss of Single Utility Source (Loss of Source to Bus A, B, C, or D)

1. When the utility voltage or frequency falls out of tolerance, as detected by the PLC from the line PTs on the Main Circuit Breaker CB MS(X), the Utility Failure timer in the PLC starts. When this timer expires, Main Circuit Breaker CB MS(X) Opens.

2. Refer to Section 1.4 for initial Bus and Circuit Breaker conditions.

3. Sequence: Utility out of tolerance.

    a. Utility Failure timer starts.

        1) If the utility returns before timer expires, system remains in initial state. Timer will be adjustable and initially set at 3 seconds.

    b. Utility Failure timer expires. Send an alarm to the control system indicating loss of single source.

    c. Open Breaker MS(X).

        1) If MS(X) fails to open: Open the two tie breakers that are closed in on that bus to isolate the Bus S(X).

    d. No further steps, the Bus will be fed through the ring bus and tie breakers.

4. Final Bus and Circuit Breaker Conditions:

    a. MS(X): Open

    b. All other Main Breakers: Closed

    c. STA, STB, STC, STD: Closed

    d. All feeder breakers closed

    e. Generators are Offline

B. Return of Utility during Loss of Single Source Event

1. When the utility voltage and frequency return within tolerance, the Utility Stable timer in the PLC starts if the Return Control switch is in Auto. When the timer expires, the Utility Breaker will Close back in.

2. Refer to Section 1.6.A for initial Bus and Circuit Breaker conditions.

3. Sequence: Utility is within tolerance as monitored from the Line PTs at MS(X).

   a. Utility Stable timer starts.

      1) If utility is lost before timer expires, system remains with MS(X) open.

   b. Utility Stable timer expires.

   c. Main Breaker MS(X) Closes:

      1) If circuit breaker MS(X) fails to close, system remains as is.

4. Refer to Section 1.4 for final Bus and Circuit Breaker conditions.

C. Loss of Multiple Utility Sources

1. When the utility voltage or frequency falls out of tolerance, as detected by the PLC from the line PTs on Multiple Main Circuit Breakers (MSA, MSB, MSC, or MSD), the Utility Failure timer in the PLC starts. When this timer expires, the Main Circuit Breakers with loss of voltage Open.

2. Refer to Section 1.4 for initial Bus and Circuit Breaker conditions.

3. Sequence: Utility out of tolerance.

   a. Utility Failure timer starts.

      1) If the utility returns before timer expires, system remains in initial state. Timer will be adjustable and initially set at 3 seconds.

   b. Utility Failure timer expires. Send an alarm to the control system indicating loss of sources. The control system shall monitor the load that is on the utility buses.

      1) If the load on the South Switching Station is greater than the capacity of the remaining Utility Feeders (9MVA each) then the system shall initiate a load shed sequence. The control system shall open feeder breakers in reverse priority order. Refer to Section 1.12.B.2 for breaker priority list. Initiate an alarm that N+1 redundancy has been lost. Proceed with the Sequence.

      2) If the load on the South Switching Station is less than the capacity of the remaining Utility Feeders (9MVA each), send an alarm to the control system that N+1 redundancy has been lost. Proceed with the sequence.

   c. Open Utility Breakers with loss of voltage.

1) If MS(X) fails to open: Open the two tie breakers that are closed in on that bus to isolate the Bus S(X).

d. No further steps, the Bus will be fed through the ring bus and tie breakers.

4. Final Bus and Circuit Breaker Conditions:

a. MS(X) (Loss of Voltage): Open

b. All other Main Breakers: Closed

c. STA, STB, STC, STD: Closed

d. All feeder breakers closed

e. Generators are Offline

D. Complete Loss of Utility (Buses A-D)

1. When the utility voltage or frequency falls out of tolerance, as detected by the PLC from the line PTs on Multiple Main Circuit Breakers (MSA, MSB, MSC, and MSD), the Utility Failure timer in the PLC starts. When this timer expires, the Main Circuit Breakers MSA, MSB, MSC, and MSD Open. System Generators Start.

2. Refer to Section 1.4 for initial Bus and Circuit Breaker conditions.

3. Sequence: Utility out of tolerance.

a. Utility Failure timer starts.

1) If the utility returns before timer expires, system remains in initial state. Timer will be adjustable and initially set at 3 seconds.

b. Utility Failure timer expires. Send an alarm to the control system indicating loss of South Switching Station Power

c. Open Utility Breakers MSA, MSB, MSC, and MSD and all Non-Priority 1 Breakers on the South Switching Station. Initiate an Alarm

1) If MS(X) fails to open: Open the two tie breakers that are closed in on that bus to isolate the Bus S(X).

d. If Howard Hall is aligned to the South Switching Station, Proceed to Section 1.7.F – Loss of Source (X)A and (X)B (Power is Not available at Source Switching Station).

e. If Howard Hall is aligned to the North Switching Station, initiate an alarm.

E. Return of Utility Sources (A-D)

1. Refer to Section 1.9.B – Return of Utility Source

## 1.7 HOWARD HALL 15KV SWITCHGEAR AUTOMATIC PROCEDURES

A. Loss of Source (X)A, System on (X)A ((X) indicates N or S for North or South Switching Station)

1. When the utility voltage or frequency falls out of tolerance, as detected by the PLC from the line PTs on CB H(X)A, the Utility Failure timer in the PLC starts. When this timer expires, the building loads transfer to CB H(X)B.

2. Refer to Section 1.4 for initial Bus and Circuit Breaker conditions.

3. Sequence: Utility out of tolerance.

a. Utility Failure timer starts.

1) If the utility returns before timer expires, system remains in initial state. Timer will be adjustable and initially set at 3 seconds.

b. Utility Failure timer expires.

c. Open Main Breaker H(X)A.

1) If H(X)A fails to open: Open circuit breaker H(X)B to isolate Howard Hall 15kV Switchgear. Proceed to Loss of Source (X)A and (X)B.

d. Close Tie Breaker HT.

1) If HT fails to close: Terminate Sequence. Power to downstream equipment will be restored through transfers on 480V equipment.

e. The remainder Breakers of the system shall remain as is.

4. Final Bus and Circuit Breaker Conditions:

a. H(X)A: Open

b. H(X)B: Closed

c. HT: Closed

d. All feeder breakers closed

e. Generators are Offline

B. Return of Source (X)A ((X) indicates N or S for North or South Switching Station)

1. When the utility voltage and frequency return within tolerance, the Utility Stable timer in the PLC starts if the Return Control switch is in Auto. When the timer expires, the Howard Hall 15kV Switchgear loads transfer from Source (X)B power only back to split bus Source (X)A and (X)B power. There will be no loss of power to the facility loads during the closed transition transfer.

2. Refer to Section 1.7 – A for initial Bus and Circuit Breaker conditions.

3. Sequence: Utility is within tolerance as monitored from the Line PTs at H(X)A.

a. Utility Stable timer starts.

1) If utility is lost before timer expires, system remains source H(X)B.

b. Utility Stable timer expires.

c. Main Breaker HNA Closes:

1) If circuit breaker H(X)A fails to close, remain on H(X)B and terminate the sequence.

d. Live/Live Closed Transfer timer starts. The Closed Transfer timer will be initially set such that the total paralleled time during transfer is 100ms.

e. Live/Live Closed Transfer timer expires.

f. Tie breaker HT opens.

1) If circuit breaker HT fails to open, open circuit breaker H(X)A and initiate system alarm.

g. The facility operates on utility power with HH 15kV Switchgear energized in a split bus configuration.

4. Refer to Section 1.4 for final Bus and Circuit Breaker conditions.

C. Loss of Source (X)B ((X) indicates N or S for North or South Switching Station)

1. When the utility voltage or frequency falls out of tolerance, as detected by the PLC from the line PTs on CB H(X)B, the Utility Failure timer in the PLC starts. When this timer expires, the building loads transfer to CB H(X)A.

2. Refer to Section 1.4 for initial Bus and Circuit Breaker conditions.

3. Sequence: Utility out of tolerance.

   a. Utility Failure timer starts.

      1) If the utility returns before timer expires, system remains in initial state. Timer will be adjustable and initially set at 3 seconds.

   b. Utility Failure timer expires.

   c. Open Main Breaker H(X)B.

      1) If H(X)B fails to open: Open circuit breaker H(X)A to isolate Howard Hall 15kV Switchgear. Proceed to Loss of Source (X)A and (X)B.

   d. Close Tie Breaker HT.

      1) If HT fails to close: Terminate Sequence. Power to downstream equipment will be restored through transfers on 480V equipment.

   e. The remainder Breakers of the system shall remain as is.

4. Final Bus and Circuit Breaker Conditions:

   a. H(X)A: Closed

   b. H(X)B: Open

   c. HT: Closed

   d. All feeder breakers closed

   e. Generators are Offline

D. Return of Source NB (X)B ((X) indicates N or S for North or South Switching Station)

1. When the utility voltage and frequency return within tolerance, the Utility Stable timer in the PLC starts if the Return Control switch is in Auto. When the timer expires, the Howard Hall 15kV Switchgear loads transfer from Source NA power only back to split bus Source (X)A and (X)B power. There will be no loss of power to the facility loads during the closed transition transfer.

2. Refer to Section 1.7 – C for initial Bus and Circuit Breaker conditions.

3. Sequence: Utility is within tolerance as monitored from the Line PTs at H(X)B.

a. Utility Stable timer starts.

1) If utility is lost before timer expires, system remains source H(X)A.

b. Utility Stable timer expires.

c. Main Breaker H(X)B Closes:

1) If circuit breaker H(X)B fails to close, remain on H(X)A and terminate the sequence.

d. Live/Live Closed Transfer timer starts. The Closed Transfer timer will be initially set such that the total paralleled time during transfer is 100ms.

e. Live/Live Closed Transfer timer expires.

f. Tie breaker HT opens.

1) If circuit breaker HT fails to open, open circuit breaker H(X)B and initiate system alarm.

g. The facility operates on utility power with HH 15kV Switchgear energized in a split bus configuration.

4. Refer to Section 1.4 for final Bus and Circuit Breaker conditions.

E. Loss of Source NA and NB – Howard Hall on North Switching Station (Power is available at North Switching Station and South Switching Station)

1. When the utility voltage or frequency falls out of tolerance as detected by the PLC from the line PTs at HNA and HNB, the Utilities Failure timer in the PLC starts. At the same time, stable voltage is detected by the line PT's on HSA and HSB. Sequence will transfer the power source from the North to the South Switching Station.

2. Refer to Section 1.4 for initial Bus and Circuit Breaker conditions.

3. Sequence: Utility out of tolerance.

a. Utility Failure timer starts.

1) If the utility returns before timer expires, system remains in initial state. Timer will be adjustable and initially set at 3 seconds.

b. Utility Failure timer expires for both HNA source and HNB source.

c. HNA, HNB, and HT Breakers shall open.

1) If HNA breaker fails to open: Proceed with sequence but do not attempt to close HSA. Hardwired electrical interlocks will prevent this breaker from closing as well.

2) If HNB breaker fails to open: Proceed with sequence but do not attempt to close HSB. Hardwired electrical interlocks will prevent this breaker from closing as well.

3) If Tie breaker HT fails to open: Open breaker HNB and keep HSB open.

d. Close Main Breaker HSA.

1) If HSA fails to close, close Tie Breaker HT and proceed to next step.

e. Close Main Breaker HSB.

1) If HSB fails to close, close Tie Breaker HT.

4. Final Bus and Circuit Breaker Conditions:

a. HNA: Open

b. HNB: Open

c. HSA: Closed

d. HSB: Closed

e. HT: Open

f. All feeder breakers closed

g. Generators are Offline

F. Loss of Source SA and SB – Howard Hall on South Switching Station (Power is available at North Switching Station and South Switching Station)

1. When the utility voltage or frequency falls out of tolerance as detected by the PLC from the line PTs at HSA and HSB, the Utilities Failure timer in the PLC starts. At the same time, stable voltage is detected by the line PT's on HNA and HNB. Sequence will transfer the power source from the North to the South Switching Station.

2. Refer to Section 1.4 for initial Bus and Circuit Breaker conditions.

3. Sequence: Utility out of tolerance.

a. Utility Failure timer starts.

1) If the utility returns before timer expires, system remains in initial state. Timer will be adjustable and initially set at 3 seconds.

b. Utility Failure timer expires for both HSA source and HSB source.

c. HSA, HSB, and HT Breakers shall open.

1) If HSA breaker fails to open: Proceed with sequence but do not attempt to close HNA. Hardwired electrical interlocks will prevent this breaker from closing as well.

2) If HSB breaker fails to open: Proceed with sequence but do not attempt to close HNB. Hardwired electrical interlocks will prevent this breaker from closing as well.

3) If Tie breaker HT fails to open: Open breaker HSB and keep HNB open.

d. Close Main Breaker HNA.

1) If HNA fails to close, close Tie Breaker HT and proceed to next step.

e. Close Main Breaker HNB.

1) If HNB fails to close, close Tie Breaker HT.

4. Final Bus and Circuit Breaker Conditions:

a. HNA: Closed

b. HNB: Closed

c. HSA: Open

d. HSB: Open

e. HT: Open

f. All feeder breakers closed

g. Generators are Offline

G. Loss of Source (X)A and (X)B (Power is Not available at the Source Switching Station)

1. When the utility voltage or frequency falls out of tolerance as detected by the PLC from the line PTs at H(X)A and H(X)B, the Utilities Failure timer in the PLC starts. When the timer expires, the load shed scheme will be initiated and the campus generators will be brought online to provide power to the North Switching Station.

2. Refer to Section 1.4 for initial Bus and Circuit Breaker conditions.

3. Sequence: Source at H(X)A and H(X)B out of tolerance.

a. Utility Failure timer starts.

1) If the utility returns before timer expires, system remains in initial state. Timer will be adjustable and initially set at 3 seconds.

b. Utility Failure timer expires for both Utility H(X)A and Utility H(X)B.

c. Proceed to Section 1.9.A - Loss of Voltage to Both Buses in Howard Hall 15kV Switchgear (Source Switching Station also has loss of voltage).

H. Return of Source (X)A and (X)B (System is on Generators)

a. Refer to Section 1.9.B – Return of Utility Source

## 1.8 HOWARD HALL 15KV SWITCHGEAR MANUAL PROCEDURES

A. Transfer from Split Bus (X)A+(X)B to (X)A only

1. The following procedure will be operator initiated. The operator shall be able to initiate the procedure by selecting this procedure from a procedures screen. When the procedure is selected a prompt shall pop-up asking the operator to confirm the selection. If the initial conditions do not match as described below, the procedure shall not be able to be selected from the procedures list.

2. Initial Conditions:

a. Main Breakers H(X)A and H(X)B: CLOSED.

b. Tie Breaker HT: OPEN

c. Generators Offline. System Receiving Normal Power through the Source Switching Station

3. Sequence:

a. Operator Selects the Procedure from the HMI.

b. Close Tie Breaker HT.

1) If HT fails to Close: Cancel procedure, initiate an alarm.

c. Open Main Breaker H(X)B

1) If (HX)B fails to Open: Open HT and all feeder breakers on HH 15KV Switchgear Bus B. Initiate an Alarm.

4. Final Bus and Circuit Breaker Conditions

a. H(X)A: Closed

b. H(X)B: Open

c. HT: Closed

d. All Feeder Breakers Closed

e. Generators Offline

B. Transfer from Split Bus (X)A+(X)B to (X)B only

1. The following procedure will be operator initiated. The operator shall be able to initiate the procedure by selecting this procedure from a procedures screen. When the procedure is selected a prompt shall pop-up asking the operator to confirm the selection. If the initial conditions do not match as described below, the procedure shall not be able to be selected from the procedures list.

2. Initial Conditions:

a. Main Breakers H(X)A and H(X)B: CLOSED.

b. Tie Breaker HT: OPEN

c. Generators Offline. System Receiving Normal Power through the Source Switching Station

3. Sequence:

a. Operator Selects the Procedure from the HMI.

b. Close Tie Breaker HT.

1) If HT fails to Close: Cancel procedure, initiate an alarm.

c. Open Main Breaker H(X)A

1) If H(X)A fails to Open: Open HT and all feeder breakers on HH 15KV Switchgear Bus A. Initiate an Alarm.

4. Final Bus and Circuit Breaker Conditions

    a. H(X)A: Open

    b. H(X)B: Closed

    c. HT: Closed

    d. All Feeder Breakers Closed

    e. Generators Offline

C. Transfer from (X)A only to Split Bus (X)A+(X)B

1. The following procedure will be operator initiated. The operator shall be able to initiate the procedure by selecting this procedure from a procedures screen. When the procedure is selected a prompt shall pop-up asking the operator to confirm the selection. If the initial conditions do not match as described below, the procedure shall not be able to be selected from the procedures list.

2. Initial Conditions:

    a. Main Breaker H(X)A: CLOSED

    b. Main Breaker H(X)B: OPEN

    c. Tie Breaker HT: CLOSED

    d. Generators Offline. System Receiving Normal Power through the Source Switching Station

    e. Normal Voltage and Frequency is Available at H(X)B as determined by the Line PT's.

3. Sequence:

    a. Operator Selects the Procedure from the HMI.

    b. Close Main Breaker H(X)B.

        1) If H(X)B fails to Close: Cancel procedure, initiate an alarm.

    c. Open Tie Breaker HT

        1) If HT fails to Open: Open (X)B and initiate an Alarm.

4. Final Bus and Circuit Breaker Conditions

a. H(X)A: Closed

b. H(X)B: Closed

c. HT: Open

d. All Feeder Breakers Closed

e. Generators Offline

D. Transfer from H(X)B only to Split Bus H(X)A+H(X)B

1. The following procedure will be operator initiated. The operator shall be able to initiate the procedure by selecting this procedure from a procedures screen. When the procedure is selected a prompt shall pop-up asking the operator to confirm the selection. If the initial conditions do not match as described below, the procedure shall not be able to be selected from the procedures list.

2. Initial Conditions:

a. Main Breaker H(X)A: OPEN

b. Main Breaker H(X)B: CLOSED

c. Tie Breaker HT: CLOSED

d. Generators Offline. System Receiving Normal Power through the Source Switching Station

e. Normal Voltage and Frequency is Available at H(X)A as determined by the Line PT's.

3. Sequence:

a. Operator Selects the Procedure from the HMI.

b. Close Main Breaker H(X)A.

1) If H(X)A fails to Close: Cancel procedure, initiate an alarm.

c. Open Tie Breaker HT

1) If HT fails to Open: Open H(X)A and initiate an Alarm.

4. Final Bus and Circuit Breaker Conditions

a. H(X)A: Closed

b. H(X)B: Closed

c. HT: Open

d. All Feeder Breakers Closed

e. Generators Offline

E. Transfer from North SS (Split bus NA+NB) to South SS (Split bus SA+SB)

1. The following procedure will be operator initiated. The operator shall be able to initiate the procedure by selecting this procedure from a procedures screen. When the procedure is selected a prompt shall pop-up asking the operator to confirm the selection. If the initial conditions do not match as described below, the procedure shall not be able to be selected from the procedures list.

2. Initial Conditions:

a. Main Breaker HNA: CLOSED

b. Main Breaker HNB: CLOSED

c. Main Breaker HSA: OPEN

d. Main Breaker HSB: OPEN

e. Tie Breaker HT: OPEN

f. Generators Offline. System Receiving Normal Power through the Source Switching Station

g. Normal Voltage and Frequency is Available at HSA and HSB as determined by the Line PT's.

3. Sequence:

a. Operator Selects the Procedure from the HMI.

b. Generators Start and Parallel together on the HH 15KV Generator Switchgear. Refer to section 1.13.A – Run Request To All Generators (Howard Hall and Peaking Plant).

c. When generators are paralleled on the generator bus parallel the generators to the HH utilty source. Close breakers MG1 and MG2.

1) If MG1 or MG2 fails to close: Initiate an alarm and abandon the procedure.

d. Open Main Breakers HNA and HNB. Howard Hall is now being fed by the generators.

1) If HNA or HNB fails to Open: Initiate an alarm and abandon the procedure.

e. Generator controls shall begin to synchronize with South Switching Station utilizing line PT's HSA and HSB.

f. When generator control system has paralleled with HSA and HSB sources, close HSA and HSB breakers.

1) If HSA or HSB fails to close: Close HT and continue with the procedure.

g. Begin unload of generators.

h. When generators have unloaded, Open Generator Breakers SB-G1 through SB-G7, A-G1, B-G1, B-G3, A-F3 and B-F3.

1) If any generator breakers on the HH 15kV Generator Switchgear fail to open: initiate an alarm and isolate that bus by opening the MG1 or MG2 and the tie breaker.

2) If any generator breakers on the Peaking Plant Switchgear fail to open: initiate an alarm and isolate that bus by opening breakers A-F1 or B-F1 and the T-1 tie breaker.

3) If A-F3 or B-F3 fail to open: Initiate an alarm and open the corresponding breaker in the Howard Hall 15kV Generator Switchgear, SB-G7 or SB-G8.

4. Final Bus and Circuit Breaker Conditions

a. HNA: Open

b. HNB: Open

c. HSA: Closed

d. HSB: Closed

e. HT: Open

f. All Feeder Breakers Closed

g. Generators Offline

F. Transfer from South SS (Split bus SA+SB) to North SS (Split bus NA+NB)

1. The following procedure will be operator initiated. The operator shall be able to initiate the procedure by selecting this procedure from a procedures screen. When the procedure is selected a prompt shall pop-up asking the operator to confirm the selection. If the initial conditions do not match as described below, the procedure shall not be able to be selected from the procedures list.

2. Initial Conditions:

    a. Main Breaker HNA: OPEN

    b. Main Breaker HNB: OPEN

    c. Main Breaker HSA: CLOSED

    d. Main Breaker HSB: CLOSED

    e. Tie Breaker HT: OPEN

    f. Generators Offline. System Receiving Normal Power through the Source Switching Station

    g. Normal Voltage and Frequency is Available at HNA and HNB as determined by the Line PT's.

3. Sequence:

    a. Operator Selects the Procedure from the HMI.

    b. Generators Start and Parallel together on the HH 15KV Generator Switchgear. Refer to section 1.13.A – Run Request To All Generators (Howard Hall and Peaking Plant).

    c. When generators are paralleled on the generator bus parallel the generators to the HH utilty source. Close breakers MG1 and MG2.

        1) If MG1 or MG2 fails to close: Initiate an alarm and abandon the procedure.

    d. Open Main Breakers HSA and HSB. Howard Hall is now being fed by the generators.

        1) If HSA or HSB fails to Open: Initiate an alarm and abandon the procedure.

    e. Generator controls shall begin to synchronize with South Switching Station utilizing line PT's HNA and HNB.

    f. When generator control system has paralleled with HNA and HNB sources, close HNA and HNB breakers.

1) If HNA or HNB fails to close: Close HT and continue with the procedure.

g. Begin unload of generators.

h. When generators have unloaded, Open Generator Breakers SB-G1 through SB-G7, A-G1, B-G1, B-G3, A-F3 and B-F3.

1) If any generator breakers on the HH 15kV Generator Switchgear fail to open: initiate an alarm and isolate that bus by opening the MG1 or MG2 and the tie breaker.

2) If any generator breakers on the Peaking Plant Switchgear fail to open: initiate an alarm and isolate that bus by opening breakers A-F1 or B-F1 and the T-1 tie breaker.

3) If A-F3 or B-F3 fail to open: Initiate an alarm and open the corresponding breaker in the Howard Hall 15kV Generator Switchgear, SB-G7 or SB-G8.

4. Final Bus and Circuit Breaker Conditions

a. HNA: Closed

b. HNB: Closed

c. HSA: Open

d. HSB: Open

e. HT: Open

f. All Feeder Breakers Closed

g. Generators Offline

## 1.9 HOWARD HALL GENERATOR PARALLELING SWITCHGEAR AND PEAKING PLANT GENERATOR SWITCHGEAR

A. Loss of Voltage to Both Buses in Howard Hall 15kV Switchgear (Source Switching Station also has loss of voltage)

1. When the utility voltage or frequency falls out of tolerance as detected by the PLC from the line PTs in the Howard hall 15kV Switchgear, the Utilities Failure timer in the PLC starts. The building loads transfer to standby generator power.

2. Refer to Section 1.04 for initial Bus and Circuit Breaker conditions.

3. Sequence: Utility out of tolerance.

    a. Utility Failure timer starts.

        1) If the utility returns before timer expires, system remains in initial state. Timer will be adjustable and initially set at 3 seconds.

    b. Utility Failure timer expires for both the A Bus and B Bus.

    c. Open Howard Hall 15kV Main breakers HNA, HNB, HSA, and HSB, and all non-priority 1 Breakers at Howard Hall, BRB, and Source Switching Station.

        1) If non-priority 1 Breaker in Source Switching Station fails to open, open Howard Hall 15kV Main Breakers (H(X)A and H(X)B).

        2) If non-priority 1 breaker in Howard Hall 15kV Switchgear fails to open, isolate that bus by opening the 15kV Main Breakers on that bus HNX and HSX, the tie HT, and the Generator Breaker on that bus, GX.

        3) If non-priority 1 Breaker in Howard Hall or Bressler Research Building 480V Switchgear fails to open, then isolate that bus by opening the Main 480V breaker and Tie Breaker.

    d. Open Howard Hall Generator Switchgear Breakers MG1 and MG2.

        1) If MG1 or MG2 fails to open: Initiate an alarm and open corresponding breaker G1 or G2. Continue with Procedure.

    e. Initiate start signal for all standby engines (HH Roof 1500kW, HH Roof 1100kW, and Peaking Plant Gas Generators). Refer to Section 1.13.A – Run Request To All Generators (Howard Hall and Peaking Plant) for Generator Startup Sequence.

        1) If a generator breaker fails to close, the still operable circuit breakers shall close once the associated engine reaches rated voltage and frequency. The remaining engine shall enter cooldown mode and shutdown.

        2) If a generator fails to reach rated voltage and frequency, the sequence shall be aborted and a system alarm initiated.

    f. When both Howard Hall generators have paralleled, close breakers MG1 and MG2.

        1) If MG1 or MG2 breakers fail to close: Initiate an alarm and continue with procedure.

    g. Close Howard Hall 15kV breakers in order of priority.

1) If any breaker fails to close, alarm and proceed with sequence.

h. When HSF3 and Howard Hall 15kV switchgear re-energization sequence has been completed and HSF3 and Howard Hall generators have been paralleled, Close Howard Hall 15kV Main Breakers HXA and HXB to energize the Source Switching Station.

1) If HXA or HXB fails to close, alarm and proceed with sequence.

i. Switchgear control system shall analyze the available generator capacity and existing system load. The Control system shall close in feeder breakers on the Source Switching Station according to the priority list and available generator capacity.

4. Final Bus and Circuit Breaker Conditions:

a. HXA (to Source Switching Station): Closed

b. HXB (to Source Switching Station): Closed

c. HT: Closed

d. XMA, XMB, XMC, XMD (Source Switching Station): Open

e. Source Switching Station: Load shed mode

f. Generators are Online. Howard Hall and Peaking Plant, paralleled.

B. Return of Utility Source

1. When the utility voltage and frequency return within tolerance for three or more utility breakers from the Source Switching Station, the Utility Stable timer in the PLC starts if the Return Control switch is in Auto. When the timer expires, the generators will synchronize to the Utility at the Source Switching Station and loads will be transferred from generator to utility power. There will be a loss of power to the facility loads during the open transition transfer.

2. Refer to Section 1.9 – A for initial Bus and Circuit Breaker conditions.

3. Sequence: Utility is within tolerance as monitored from the Line PTs at the Source Switching Station for three or more Utility Breakers.

a. Utility Stable timer starts (factory set to 10 minutes, adjustable).

1) If utility is lost before timer expires, system remains on generators.

b. Utility Stable timer expires.

c. Generator controls shall begin to synchronize with the Source Switching Station by utilizing the Line PT's at MXA, MXB, MXC, or MXD.

d. When the generator control system has paralleled the generators with the utility source, close Main Breaker XMA in the Source Switching Station.

1) If circuit breaker XMA fails to close, initiate system alarm and proceed with sequence.

e. Main breaker XMB in the Source Switching Station closes.

1) If circuit breaker XMB fails to close, initiate system alarm and proceed with sequence.

f. Main breaker XMC in the Source Switching Station closes.

1) If circuit breaker XMC fails to close, initiate system alarm and proceed with sequence.

g. Main breaker XMD in the Source Switching Station closes.

1) If circuit breaker XMD fails to close, initiate system alarm and proceed with sequence.

h. When two Utility Breakers have closed, begin soft unloading the generators.

i. When generators have unloaded, Open Generator Breakers SB-G1 through SB-G7, A-G1, B-G2, B-G3, A-F3 and B-F3.

1) If any generator breakers on the HH 15kV Generator Switchgear fail to open: initiate an alarm and isolate that bus by opening the MG1 or MG2 and the tie breaker.

2) If any generator breakers on the Peaking Plant Switchgear fail to open: initiate an alarm and isolate that bus by opening breakers A-F1 or B-F1 and the T-1 tie breaker.

3) If A-F3 or B-F3 fail to open: Initiate an alarm and open the corresponding breaker in the Howard Hall 15kV Generator Switchgear, SB-G7 or SB-G8.

j. All feeder breakers close in priority order.

1) If any feeder breaker fails to close, initiate an alarm and proceed with the sequence.

k. The facility operates on utility power.

4. Refer to Section 1.4 for final Bus and Circuit Breaker conditions.

C. Loss of Voltage to HSF3 (Only at HSF3)

1. When the utility voltage or frequency falls out of tolerance as detected by the existing HSF3 control system, a generator start signal will be transferred to the new Control System. The new control system shall detect stable voltage at the North and South Switching Station, meaning that HSF3 has lost power. HSF3 will have power restored by the Peaking Plant Generators.

2. Refer to Section 1.04 for initial Bus and Circuit Breaker conditions.

3. Sequence: Generator start signal received from HSF3 control system.

a. Stable voltage is detected on the North and South Switching Station Buses.

b. Open Breakers A-F1 and B-F1.

1) If A-F1 or B-F1 fails to Open: Open tie breaker T-1 and begin shutdown sequence of the generators on that bus. Initiate an alarm.

c. Initiate startup of Peaking Plant Generators Once the first engine has reached rated voltage and frequency, close the associated breaker. The remaining engines shall synchronize with the online engine and the associated breaker close.

1) If a generator breaker fails to close, the still operable circuit breakers shall close once the associated engine reaches rated voltage and frequency. The remaining engine shall enter cooldown mode and shutdown.

2) If a generator fails to reach rated voltage and frequency, the sequence shall be aborted and a system alarm initiated.

d. Close Breakers A-F1 and B-F1.

1) If A-F1 or B-F1 fails to close, initiate an alarm and continue with the procedure.

e. HSF3 is fed from the peaking plant generators. HSF3 existing control system restores load to HSF3.

4. Final Bus and Circuit Breaker Conditions:

a. A-F1: Closed

b. B-F1: Closed

c. A-F3: Open

d. B-F3: Open

e. T-1: Closed

f. A-G1: Closed

g. B-G2: Closed

h. B-G3: Closed

D. Return of Voltage to HSF3 (Only HSF3 without utility power)

1. When the utility voltage and frequency return to stable as detected by the GE modified HSF3 control system, the HSF3 GE Automation System shall send generator frequency control signals to the generator control system to begin synchronization with utility. The HSF3 GE Automation System shall continue to modulate the generators frequency until the HSF3 GE Automation System synchronization check is satisfied. HSF3 shall initiate a closed-transition back to utility and open the breakers to the Peaking Plant. Upon verification that the closed-transition was successful by the HSF3 control system, a generator shutdown signal is sent to the generator control system. The generator control system will begin shutdown of the generators and open the generator breakers.

2. Refer to Section 1.9.C for initial Bus and Circuit Breaker conditions.

3. Sequence: Generator shutdown signal received from HSF3 control system.

a. Generator Control system begins shutdown procedures for generators.

b. Open Breakers A-G1, B-G2, and B-G3.

1) If A-G1, B-G2, or B-G3 fails to Open: Open tie breaker T-1 and corresponding main breaker A-F1 or B-F1 to isolate that bus. Initiate an alarm and continue with procedure.

4. Refer to Section 1.4 for final Bus and Circuit Breaker conditions.

E. No Load Testing

1. Operator Selects No Load Test from the HMI

a. All available generators are started.

b. The system remains in No Load Test Mode until Operator ends the test mode from the HMI.

c. When the operator ends the No Load Test Mode from the HMI, the generators are allowed to run for their programmed cool down period.

d. The system returns to Auto/Standby mode.

F. Utility Fail Test Mode

1. Operator Selects Utility Fail Test Mode from the HMI

a. The Source Switching Station Fail Test Switch is placed in the ON position.

b. Voltage sensing at the 4 utility BG&E service entrance breakers protective relay are opened, which simulates a loss of utility.

c. The system enters into a Sequence for Complete Loss of Utility (Section 1.5.D or 1.6.D).

d. Exit from Source Switching Station Fail Test Mode

e. The Source Switching Station Fail Test Switch is placed in the OFF position.

f. Voltage sensing at the 4 utility BG&E service entrance protective relays is restored, which simulates the return of utility power.

g. The system exits from a Source Switching Station Failure as described in Section 1.9.B – Return of Utility Source.

G. Live Load Test Mode

a. Parallel Gens and do closed transition.

b. Load gens using Howard Hall

c. Turn on/off gens as needed

d. Transfer back to utility

e. Shutdown Generators

H. Load Management Demand Reponse

1. The generator control system shall be capable of receiving demand response signal from the BAS system to start individual generators for demand response purposes. The BAS system will send a signal to the switchgear control system to enter demand response mode and start the generators. Under this project, the contractor shall provide the hardwired points from the BAS system to start the generators. A future project will incorporate the signals into the BAS system. Refer to specification 262313, 2.18.C for details.

## 1.10 HOWARD HALL AND BRESSLER RESEARCH BUILDING 480V SWITCHGEAR AUTOMATIC PROCEDURES

A. Loss of Voltage to Bus A Line Side

1. When the utility voltage or frequency falls out of tolerance, as detected by the PLC from the line PTs on the Bus A Main Breaker, the Utility Failure timer in the PLC starts. When this timer expires, the building loads transfer to Bus B.

2. Refer to Section 1.4 for initial Bus and Circuit Breaker conditions.

3. Sequence: Utility out of tolerance.

   a. Utility Failure timer starts.

      1) If the utility returns before timer expires, system remains in initial state. Timer will be adjustable and initially set at 3 seconds.

   b. Utility Failure timer expires.

   c. Open Main Breaker on Bus A.

      1) If Main Breaker fails to open: Open the 15kV Breaker HA and initiate an alarm. Proceed with the sequence.

   d. Close Tie Breaker.

      1) If Tie Breaker fails to close: Terminate Sequence. Initiate an alarm.

   e. The remainder Breakers of the system shall remain as is.

4. Final Bus and Circuit Breaker Conditions:

   a. Bus A Main Breaker: Open

   b. Bus B Main Breaker: Closed

c. Tie Breaker: Closed

d. All feeder breakers closed

e. Generators are Offline

B. Return of Voltage to Bus A Line Side of Main Breaker

1. When the utility voltage and frequency return within tolerance, the Utility Stable timer in the PLC starts. When the timer expires, the Howard Hall 480V Switchgear initiates a closed transfer from Bus B back to split bus with Source A and B. There will be no loss of power to the facility loads during the closed transition transfer.

2. Refer to Section 1.10.A for initial Bus and Circuit Breaker conditions.

3. Sequence: Utility is within tolerance as monitored from the line side of the Main Breaker.

a. Utility Stable timer starts.

1) If utility is lost before timer expires, system remains on Bus B.

b. Utility Stable timer expires.

c. Main Breaker on Bus A Closes:

1) If Bus A Main Breaker fails to close, remain on Bus B Main Breaker and terminate the sequence. Initiate an alarm.

d. Live/Live Closed Transfer timer starts. The Closed Transfer timer will be initially set such that the total paralleled time during transfer is 100ms.

e. Live/Live Closed Transfer timer expires.

f. Tie breaker opens.

1) If tie circuit breaker fails to open, open Bus A Main circuit breaker and initiate system alarm.

g. The facility operates on utility power with HH 480V Switchgear energized in a split bus configuration.

4. Refer to Section 1.4 for final Bus and Circuit Breaker conditions.

C. Loss of Voltage to Bus B Line Side

1. When the utility voltage or frequency falls out of tolerance, as detected by the PLC from the line PTs on the Bus B Main Breaker, the Utility Failure timer in the PLC starts. When this timer expires, the building loads transfer to Bus A.

2. Refer to Section 1.4 for initial Bus and Circuit Breaker conditions.

3. Sequence: Utility out of tolerance.

    a. Utility Failure timer starts.

        1) If the utility returns before timer expires, system remains in initial state. Timer will be adjustable and initially set at 3 seconds.

    b. Utility Failure timer expires.

    c. Open Main Breaker on Bus B.

        1) If Main Breaker fails to open: Open the 15kV Breaker HB and initiate an alarm. Proceed with the sequence.

    d. Close Tie Breaker.

        1) If Tie Breaker fails to close: Terminate Sequence. Initiate an alarm.

    e. The remainder Breakers of the system shall remain as is.

4. Final Bus and Circuit Breaker Conditions:

    a. Bus A Main Breaker: Closed

    b. Bus B Main Breaker: Open

    c. Tie Breaker: Closed

    d. All feeder breakers closed

    e. Generators are Offline

D. Return of Voltage to Bus B Line Side of Main Breaker

1. When the utility voltage and frequency return within tolerance, the Utility Stable timer in the PLC starts. When the timer expires, the Howard Hall 480V Switchgear initiates a closed transfer from Bus A back to split bus with Source A and B. There will be no loss of power to the facility loads during the closed transition transfer.

2. Refer to Section 1.10 – C for initial Bus and Circuit Breaker conditions.

3. Sequence: Utility is within tolerance as monitored from the Line side of the Main Breaker.

   a. Utility Stable timer starts.

      1) If utility is lost before timer expires, system remains on Bus A.

   b. Utility Stable timer expires.

   c. Main Breaker on Bus B Closes:

      1) If Bus B Main Breaker fails to close, remain on Bus A Main Breaker and terminate the sequence. Initiate an alarm.

   d. Live/Live Closed Transfer timer starts. The Closed Transfer timer will be initially set such that the total paralleled time during transfer is 100ms.

   e. Live/Live Closed Transfer timer expires.

   f. Tie breaker opens.

      1) If tie circuit breaker fails to open, open Bus B Main circuit breaker and initiate system alarm.

   g. The facility operates on utility power with HH 480V Switchgear energized in a split bus configuration.

      1) Refer to Section 1.4 for final Bus and Circuit Breaker conditions.

E. Loss of Voltage to Bus A and B Line Side of Main Breaker

1. When the utility voltage or frequency falls out of tolerance, as detected by the PLC from the line PTs on the Bus A Main Breaker and Bus B Main Breaker, the Utility Failure timer in the PLC starts. The feeder breakers open and the system waits to be restored by generator power.

2. Refer to Section 1.4 for initial Bus and Circuit Breaker conditions.

3. Sequence: Utility out of tolerance.

   a. Utility Failure timer starts.

      1) If the utility returns before timer expires, system remains in initial state. Timer will be adjustable and initially set at 3 seconds.

   b. Utility Failure timer expires.

c. Open non-priority 1 breakers. The system will be restored according to section 1.9.A.

## 1.11 HOWARD HALL AND BRESSLER RESEARCH BUILDING 480V SWITCHGEAR MANUALLY INITIATED PROCEDURES

A. Transfer from Split Bus Main A + Main B to Main A Only

1. The following procedure will be operator initiated. The operator shall be able to initiate the procedure by selecting this procedure from a procedures screen. When the procedure is selected a prompt shall pop-up asking the operator to confirm the selection. If the initial conditions do not match as described below, the procedure shall not be able to be selected from the procedures list.

2. Initial Conditions:

   a. Main Breakers Main A and Main B: CLOSED.

   b. Tie Breaker: OPEN

3. Sequence:

   a. Operator Selects the Procedure from the HMI.

   b. Close Tie Breaker.

      1) If Tie Breaker fails to Close: Cancel procedure, initiate an alarm.

   c. Open Main Breaker B

      1) If Main Breaker B fails to Open: Open Tie Breaker and initiate an Alarm.

4. Final Bus and Circuit Breaker Conditions

   a. Main Breaker A: Closed

   b. Main Breaker B: Open

   c. Tie Breaker: Closed

B. Transfer from Split Bus Main A + Main B to Main B Only

1. The following procedure will be operator initiated. The operator shall be able to initiate the procedure by selecting this procedure from a procedures screen. When the procedure

is selected a prompt shall pop-up asking the operator to confirm the selection. If the initial conditions do not match as described below, the procedure shall not be able to be selected from the procedures list.

2. Initial Conditions:

   a. Main Breakers Main A and Main B: CLOSED.

   b. Tie Breaker: OPEN

3. Sequence:

   a. Operator Selects the Procedure from the HMI.

   b. Close Tie Breaker.

      1) If Tie Breaker fails to Close: Cancel procedure, initiate an alarm.

   c. Open Main Breaker A

      1) If Main Breaker A fails to Open: Open Tie Breaker and initiate an Alarm.

4. Final Bus and Circuit Breaker Conditions

   a. Main Breaker A: Open

   b. Main Breaker B: Closed

   c. Tie Breaker: Closed

C. Transfer from Main A only to Split Bus Main A + Main B

1. The following procedure will be operator initiated. The operator shall be able to initiate the procedure by selecting this procedure from a procedures screen. When the procedure is selected a prompt shall pop-up asking the operator to confirm the selection. If the initial conditions do not match as described below, the procedure shall not be able to be selected from the procedures list.

2. Initial Conditions:

   a. Main Breaker Main Breaker A: CLOSED

   b. Main Breaker Main Breaker B: OPEN

   c. Tie Breaker: CLOSED

   d. Normal Voltage and Frequency is Available at Line Side of Main B Breaker.

3. Sequence:

    a. Operator Selects the Procedure from the HMI.

    b. Close Main Breaker B.

        1) If Main Breaker B fails to Close: Cancel procedure, initiate an alarm.

    c. Open Tie Breaker

        1) If Tie Breaker fails to Open: Open Main Breaker B and initiate an Alarm.

4. Final Bus and Circuit Breaker Conditions

    a. Main Breaker A: Closed

    b. Main Breaker B: Closed

    c. Tie Breaker: Open

D. Transfer from Main B only to Split Bus Main A + Main B

1. The following procedure will be operator initiated. The operator shall be able to initiate the procedure by selecting this procedure from a procedures screen. When the procedure is selected a prompt shall pop-up asking the operator to confirm the selection. If the initial conditions do not match as described below, the procedure shall not be able to be selected from the procedures list.

2. Initial Conditions:

    a. Main Breaker Main Breaker A: OPEN

    b. Main Breaker Main Breaker B: CLOSED

    c. Tie Breaker: CLOSED

    d. Normal Voltage and Frequency is Available at Line Side of Main A Breaker.

3. Sequence:

    a. Operator Selects the Procedure from the HMI.

    b. Close Main Breaker A.

        1) If Main Breaker A fails to Close: Cancel procedure, initiate an alarm.

    c. Open Tie Breaker

1) If Tie Breaker fails to Open: Open Main Breaker A and initiate an Alarm.

4. Final Bus and Circuit Breaker Conditions

a. Main Breaker A: Closed

b. Main Breaker B: Closed

c. Tie Breaker: Open

## 1.12 GENERATOR START PROCEDURES

A. Run Request To All Generators (Howard Hall and Peaking Plant)

1. The Generator Control System Receives a Run Request to All Generators.

2. Refer to Section 1.4 for initial Bus and Circuit Breaker conditions.

3. Sequence: Generator Run Request is Received for All Generators

(NOTE: *The individual life safety generators supporting the individual buildings upon loss of power will receive a start signal from the associated ATS. The ATS for these Life Safety systems shall be inhibited from retransferring to the normal side while the generator plant is supporting the loads.*)

a. The first generator up to rated voltage and frequency is closed to the HH 15KV Generator Switchgear load bus. The automation dead bus logic will prevent 2 source breakers attempting to close onto the bus simultaneously.

b. The remaining HH 15KV generators are synchronized and paralleled to the HH 15KV Generator bus as they reach rated voltage and frequency. The Peaking Plant will concurrently start and synchronize its engine generators to the 15KV Peaking Plant load bus. Upon synchronizing the Peaking Plant generators to the Peaking Plant load bus, HSFIII loads shall be added to the Peaking Plant load bus. After all generators' loads are on the load bus (factory set delay of 30 seconds to allow all loads to be added on load bus) or the expiration of the adjustable fail to synchronizing timer (factory set at 2 minutes after the load addition delay), the Peaking Plant will synchronize to the HH 15KV Generator Switchgear load bus and close the priority paralleling breaker A-F3 in the Peaking Plant Paralleling Switchgear.

1) If A-F3 fails to close: Initiate an Alarm and continue with procedure.

c. Close Breaker A-F4.

1) If A-F4 fails to close: Initiate an Alarm and continue with procedure.

d. Return to Initiating Sequence.

B. Run Request To Howard Hall Generators

1. The Generator Control System Receives a Run Request to the Howard Hall Generators Only.

2. Refer to Section 1.4 for initial Bus and Circuit Breaker conditions.

3. Sequence: Generator Run Request is Received for Howard Hall Generators

(NOTE: *The individual life safety generators supporting the individual buildings upon loss of power will receive a start signal from the associated ATS. The ATS for these Life Safety systems shall be inhibited from retransferring to the normal side while the generator plant is supporting the loads.*)

a. The first generator up to rated voltage and frequency is closed to the HH 15KV Generator Switchgear load bus. The automation dead bus logic will prevent 2 source breakers attempting to close onto the bus simultaneously.

b. The remaining HH 15KV generators are synchronized and paralleled to the HH 15KV Generator bus as they reach rated voltage and frequency.

c. Return to Initiating Sequence.

## 1.13 FEEDER BREAKER PRIORITY LIST

A. The Building and Breaker Priority List Shall be User Adjustable in the Field from the HMI screen.

B. Feeder Breaker Priority List

1. Priority 1 Feeder Breakers

1) North Switching Station

a) N3C: Campus Feeder 3C

b) N3D: Campus Feeder 3D

c) NTA: Tie Breaker to Bus B

d) NTB: Tie Breaker to Bus C

e) NTC: Tie Breaker to Bus D

f) NTD: Tie Breaker to Bus A

2) South Switching Station

a) S3C: Campus Feeder 3C

b) S3D: Campus Feeder 3D

c) STA: Tie Breaker to Bus B

d) STB: Tie Breaker to Bus C

e) STC: Tie Breaker to Bus D

f) STD: Tie Breaker to Bus A

3) Howard Hall 15kV Switchgear

a) G1 Generator Paralleling Switchgear Feeder, Bus 1

b) G2 Generator Paralleling Switchgear Feeder, Bus 2

c) B1: BRB Substation 1 Feeder

d) HA: HH Substation A Feeder

e) HB: HH Substation B Feeder

f) B2: BRB Substation 2 Feeder

g) B5: BRB Substation 5 Feeder

h) B6: BRB Substation 6 Feeder

4) Howard Hall Generator Switchgear

a) SB-G7: Peaking Plant Bus A

b) SB-G8: Peaking Plant Bus B

c) GT: Bus Tie Breaker

5) Peaking Plant Paralleling Switchgear

a) T-1: Bus Tie Breaker

b) A-F2

6) Howard Hall 480V Switchgear

a) Bus A and Bus B: Fire Pump Controller ATS Breakers.

b) Bus A and Bus B: ATS-MECH Breakers.

c) Bus A and Bus B: ATS-EQ Breakers

7) Bressler Research Building 480V Switchgear

a) Bus A and Bus B: Fire Pump Controller ATS Breakers

b) Bus B: ATS-EQ4 Breaker

c) Bus A: ATS-EQ8 Breaker

2. Remaining Breaker Priorities Table

| **Breaker Name** | **Load** | **Priority Number** |
|---|---|---|
| HH 480V – MCC-3 | MCC-3 | 2 |
| HH 480V – MCC-SB | MCC-SB | 3 |
| HH 480V – RP2W | RP2W | 4 |
| HH 480V – LP3W | LP3W | 5 |
| HH 480V – NHDP | NHDP | 6 |
| HH 480V – MCC-ERE | MCC-ERE | 7 |

| | | |
|---|---|---|
| HH 480V – Panel DP | Panel DP | 8 |
| HH 480V – Panel A | Panel A | 9 |
| HH 480V – 1H1 | 1H1 | 10 |
| HH 480V – HH DP1 | Switchboard HH DP1 | 11 |
| BRB 480V – BRB DP1 | Switchboard BRB DP1 | 12 |
| BRB 480V – TR-3I | Transformer 3I | 13 |
| BRB 480V – MCC BK | MCC BK | 14 |
| BRB 480V – TR 3J | Transformer 3J | 15 |
| BRB 480V – TR 6J | Transformer 6J | 16 |
| BRB 480V – MCC BL | MCC BL | 17 |
| BRB 480V – BRB DP2 | Switchboard BRB DP2 | 18 |
| BRB 480V – ATS 1G | ATS-1G | 19 |
| N1A/S1A | Campus Feeder 1A | 20 |
| N1B/N1B | Campus Feeder 1B | 21 |
| N4C/S4C | Campus Feeder 4C | 22 |

| | | |
|---|---|---|
| N4D/S4D | Campus Feeder 4D | 23 |
| N5A/S5A | Campus Feeder 5A | 24 |
| N5B/N5B | Campus Feeder 5B | 25 |
| HH 15KV - B8 | BRB Substation 8 | 26 |
| N2A/S2A | Campus Feeder 2A | 27 |
| N2B/N2B | Campus Feeder 2B | 28 |
| N3A/S3A | Campus Feeder 3A | 29 |
| N3B/N3B | Campus Feeder 3B | 30 |
| N4A/S2A | Campus Feeder 4A | 31 |
| N4B/N2B | Campus Feeder 4B | 32 |
| N6A/S6A | Campus Feeder 6A | 33 |
| N6B/N6B | Campus Feeder 6B | 34 |
| N1C/S1C | Campus Feeder 1C | 35 |
| N1D/S1D | Campus Feeder 1D | 36 |
| N2C/S2C | Campus Feeder 2C | 37 |

| | | |
|---|---|---|
| N2D/S2D | Campus Feeder 2D | 38 |

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

**END OF SECTION 261302**

# SECTION 262200 - LOW-VOLTAGE TRANSFORMERS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 26.

### 1.2 SUMMARY

A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:

1. Distribution transformers.

### 1.3 SUBMITTALS

A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.

B. 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.

1. Wiring Diagrams: Power, signal, and control wiring.

C. Qualification Data: For testing agency.

D. Source quality-control test reports.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

### 1.4 QUALITY ASSURANCE

Engineer: Retain paragraph A with subparagraph if Contractor chooses Agency or retain paragraph B.

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7.

C. Source Limitations: Obtain each transformer type through one source from a single manufacturer.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

## 1.5 DELIVERY, STORAGE, AND HANDLING

A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

## 1.6 COORDINATION

A. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.

## 1.7 WARRANTY/GUARANTEE

A. See Division 26 Specification Section “Basic Electrical Requirements’ for warranty and guarantee requirements.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. ACME Electric Corporation; Power Distribution Products Division.
2. Challenger Electrical Equipment Corp.; a division of Eaton Corp.
3. Eaton Electrical Inc.; Cutler-Hammer Products.
4. Sola/Hevi-Duty.
5. Square D; Schneider Electric.

### 2.2 GENERAL TRANSFORMER REQUIREMENTS

A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.

B. Cores: Grain-oriented, non-aging silicon steel.

C. Coils: Continuous windings without splices except for taps.

1. Internal Coil Connections: Brazed or pressure type.
2. Coil Material: Copper.

### 2.3 DISTRIBUTION TRANSFORMERS

A. Comply with NEMA ST 20, and list and label as complying with UL 1561.

B. Cores: One leg per phase.

C. Enclosure: Ventilated NEMA 250, Type 2.

1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.

D. Enclosure: Ventilated, NEMA 250, Type 4X, stainless steel.

1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.

E. Transformer Enclosure Finish: Comply with NEMA 250.

1. Finish Color: ANSI 49 gray.

F. Taps for Transformers 7.5 to 24 kVA: One (1) 5 % tap above and one (1) 5 % tap below normal full capacity.

G. Taps for Transformers 25 kVA and Larger: Two (2) 2.5 % taps above and two (2) 2.5 % taps below normal full capacity.

H. Insulation Class: $220^0$C, UL-component-recognized insulation system with a maximum of $115^0$C rise above $40^0$C ambient temperature.

I. Energy Efficiency for Transformers Rated 15 kVA and Larger:

1. Complying with NEMA TP 1, Class 1 and DOE 2016 efficiency levels.
2. Tested according to NEMA TP 2.

J. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.

1. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.
2. Include special terminal for grounding the shield.
3. Shield Effectiveness:

a. Capacitance between Primary and Secondary Windings: Not to exceed 33 picofarads over a frequency range of 20 Hz to 1 MHz.
b. Common-Mode Noise Attenuation: Minimum of minus 120 dBA at 0.5 to 1.5 kHz; minimum of minus 65 dBA at 1.5 to 100 kHz.
c. Normal-Mode Noise Attenuation: Minimum of minus 52 dBA at 1.5 to 10 kHz.

K. Wall Brackets: Manufacturer's standard brackets.

L. Low-Sound-Level Requirements: Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91.

M. Low-Sound-Level Requirements: Maximum sound levels, when factory tested according to IEEE C57.12.91, as follows:

1. 9 kVA and Less: 37 dBA.
2. 30 to 50 kVA: 42 dBA.
3. 51 to 150 kVA: 47 dBA.
4. 151 to 300 kVA: 52 dBA.

2.4 IDENTIFICATION DEVICES

A. Nameplates: Engraved, laminated-plastic or metal nameplate for each distribution transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section "Identification for Electrical Systems."

2.5 SOURCE QUALITY CONTROL

A. Test and inspect transformers according to IEEE C57.12.91.

B. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this Project.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.

B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

D. Verify that ground connections are in place and requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 3 ohms at location of transformer.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.

3.3 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

## 3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

C. Remove and replace units that do not pass tests or inspections and retest as specified above.

D. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

## 3.5 ADJUSTING

A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 % and not being lower than nameplate voltage minus 3% at maximum load conditions. Submit recording and tap settings as test results.

B. Output Settings Report: Prepare written report recording output voltages and tap settings.

## 3.6 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION 262200

# SECTION 262313 – SWITCHGEAR CONTROLS AND AUTOMATION

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes: Monitoring and control systems for paralleling standby generators on an isolated bus, closed transition transfers to and from the utility source and for distributing electrical power.

B. The components for the medium voltage power system inclusive of the normal service and emergency service components shall be provided by the power system integrator. The power system integrator shall be responsible for the electrical distribution system in its entirety inclusive of switchgear, substations and all required controls and auxiliaries. The power system integrator shall be an independent supplier not affiliated with a specific manufacturer to allow for complete and independent evaluation of products offered.

C. Provide as part of this bid Factory Witness Testing – Include all expenses (travel, hotel, meals) for up to four people to attend the factory test as is defined by this specification.

D. Related Requirements:

1. Section 260913 "Electrical Power Monitoring and Control" for interfacing communication and metering requirements.
2. Section 263213 "Engine Generators" for individual generator protection and controllers.
3. Section 261300 “Medium Voltage 15KV Switchgear”
4. Section 261305 “Sequence of Operation for Electrical Equipment”
5. Section 261116 “Secondary Unit Substations”

### 1.3 DEFINITIONS

A. ATS: Acceptance Testing Specification.

B. DDC: Direct digital control.

C. EPS: Engine Paralleling System

D. Legally Required: As used in this Section, it shall have the same meaning as used in NFPA 70.

1.4 SUBMITTALS

A. Compliance statement as described under the Quality Assurance section of this Specification.

B. Product Data: For each type of switchgear controls and related equipment, include the following:
   1. Rated capacities, operating characteristics, furnished specialties, and accessories.
   2. Control network topology, control cabinets and cubicle elevations and protective relay system philosophy with accompanying diagrams.

C. Product Data: Include the following:

   1. Include technical data on features, performance, electrical characteristics, ratings, and finishes for programmable logic controllers, instrumentation, control devices, monitoring devices, SCADA interface devices, and display components.
   2. Include rated capacities, operating characteristics, furnished accessories, factory settings, for individual protective relays.

D. Shop Drawings: For each type of paralleling medium voltage switchgear.
   1. Include dimensioned plans, elevations, sections, details, shipping sections, weights of each assembled section, and required clearances and service space around equipment.
   2. Include tabulation of installed devices with features and ratings.
   3. Include enclosure types and details.
   4. Detail locations for anchor bolts and leveling channels.
   5. Include point-to-point schematic control, monitoring, and alarm wiring diagrams showing internal component terminal numbers.
   6. Include point-to point schematic control, monitoring, and alarm wiring diagrams for external components indicating terminal numbers for the following:

      a. Engine generators.
      b. Other load-control devices.
      c. Elevator controller in each elevator bank.
      d. SCADA remote terminal unit.

E. Sequence of Operation: Description of sequence of operation for paralleling controls in automatic, manual, system test, and load management modes. Sequence to comply with the detailed Sequence of Operations.
   1. Include factory testing plan for control system.

F. Bidders will provide a Compliance Review of the Specifications and Addenda (if any). The Compliance Review shall be a paragraph-by-paragraph review of the Specifications with the following information, "C", "D" or "E" marked in the margin of the original Specifications and any subsequent Addenda.
   1. "C": Comply with no exceptions.
   2. "D": Comply with deviations. For each and every deviation, provide a numbered footnote with reasons for the proposed deviation and how the intent of the Specification can be satisfied.
   3. "E": Exception, do not comply. For each and every exception, provide a numbered foot-note with reasons and possible alternatives.

   Unless a deviation or exception is specifically noted in the Compliance Review, it is assumed that the Bidder is in complete compliance with the plans and Specifications. Deviations or exceptions taken in cover letters, subsidiary documents, by omission or by contradiction do not release the Bidder from being in complete compliance, unless the exception or deviation has been specifically noted in the Compliance Review. The Bidder may submit the latest state-of-the-art components in lieu of specified items for review and approval. All deviations from the Specifications must be approved by the Architect/Engineer.

G. Source quality-control reports.

H. Field quality-control reports.

I. See Division 26 Specification Section "Basic Electrical Requirements' for warranty and guarantee requirements.

1.5 CLOSEOUT SUBMITTALS

C. Operation and Maintenance Data: For paralleling switchgear and components to include in emergency, operation, and maintenance manuals.

   1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

      a. Manufacturer's written instructions for sequence of operation.
      b. Manufacturer's system checklists, maintenance schedule, and maintenance log sheets complying with NFPA 110.
      c. Copy of any Annotated PLC code and any required cables, software or special hardware required for downloading the installed PLC program from the owners PC.
      d. Operating instructions laminated and mounted adjacent to Master Control Panel location.
      e. Training plan including PLC program download into the resident controller(s).

## 1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Control Power Fuses: Six of each type and rating used. Include spares for the following:

   a. Potential transformers.
   b. Control power circuits.

2. Indicating Lights: Six of each type installed.
3. One HMI screen of each type installed in the system.
4. One PLC of each type installed in the paralleling control system.
5. One digital I/O card and one analog card of each type used in the control system.

B. Maintenance Tools: Furnish tools and miscellaneous items required for paralleling switchgear test, inspection, maintenance, and operation. Include the following:
1. A laptop with the final as built control software inclusive of PLC and HMI software to trouble shoot and repair the control system. The code shall be annotated and a print version provided as well as electronic version to the OWNER.
2. Complete as built drawings in PDF format loaded on the laptop with a spare CD provided to the OWNER.

## 1.7 QUALITY ASSURANCE

A. Compliance Statement: The equipment manufacturer shall include a Compliance Statement, at the time of Bid, listing each Specification Section, and Part 1, 2, and 3 Sub-Sections, stating, paragraph-by-paragraph, compliance with the Specification, each minor nonconformity that is within the intent of the Specification, and proposed nonconformities. Provide short description of minor nonconformities, and detailed explanation of other nonconformities.

B. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Contractor shall engage an independent third party testing agency field supervisor: Currently certified by NETA to supervise on-site testing and commissioning.

2. The power system integrator shall provide startup and commissioning test scripts for review by the engineer and the testing agency. Startup and test documents shall be supplied 12 weeks after release for manufacturer of the product.

C. System Integration

1. The power system equipment including engine generators, service entrance switchgear, system paralleling controls, protective relays, station batteries and associated equipment for the normal distribution and standby generation system shall be supplied by an independent power system integrator. The power system integrator shall be capable of evaluating the differing equipment manufactures for quality and specification compliance and be independently owned and operated from the equipment manufacturers.
2. The power system integrator shall provide the following:
    a. A quotation for manufacturers' products that meet the engineer's specification and the full intent of the project. The power system offering shall be fully compliant with the project specifications and represent the best scope offering and value to the owner.
    b. Assist the owner in the submission of the required utility interconnect agreement. The power system integrator shall attend any meetings as required by the owner or engineer to ensure complete compliance with the utility requirements for interconnection.
    c. Assist the owner in the submission of the required air quality permits. The system integrator shall attend any meetings as required by the owner or engineer to ensure complete compliance with the applicable Federal, State and local jurisdiction air permitting requirements.
    d. Assist in the development of the Method of Procedure (MOP) documents for the integration of the new system. The system integrator shall attend any meetings as required by the owner or engineer to assist in the development of the MOP.
    e. Development of the startup and commissioning documents for the power system. These document shall be submitted to the engineer and the third party commissioning service for review. The system integrator shall attend any meetings as required by the owner or engineer to assist in the development of the startup and commissioning documents.

## 1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver control sections in sections of lengths that can be moved past obstructions in delivery path. Shipping sections to be reviewed and approved by the engineer and installing contractor.

B. The Contractor shall store control system components indoors in clean dry space with uniform temperature to prevent condensation. Protect equipment from exposure to dirt, fumes, water, corrosive substances, and physical damage.

## 1.9 PROJECT CONDITIONS

C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then

only after arranging to provide temporary electric service according to requirements indicated:

1. All interruptions shall be per the approved per the construction Method of Procedure
2. Notify Construction Manager no fewer than 4 weeks in advance of proposed interruption of electric service.
3. Do not proceed with interruption of electric service without Owner's written permission.
4. Outages to existing loads shall occur during off hours.
    a. If contractor elects to do outages or switchovers during normal hours then contractor shall submit a plan to be approved by the owner and provide temporary power at no additional cost.

D. Environmental Limitations: Rate equipment for continuous operation at indicated ampere ratings for the following conditions:

1. Ambient temperature not exceeding 122 deg F.
2. Altitude of 100 ft. above sea level.

## 1.10 WARRANTY

A. Manufacturer's Warranty: The power system integrator shall ensure the equipment manufacturer agrees to repair or replace the medium and low voltage switchgear, controls, engines and other ancillary power system equipment that fails in materials or workmanship within the specified warranty period.

1. Warranty Period: Two year(s) from date of Owners written acceptance.
2. The power system integrator shall provide a contract for the entirety of the Warranty period for maintenance, inspection and warranty management in the OWNERS best interest.
3. The system integrator shall include quarterly visits over the two year period to assist owner with operational questions and/or concerns that arise to assist owner with running the system.

# PART 2 - PRODUCTS

## 2.1 POWER SYSTEM INTEGRATORS.

A. Power system integrators: Subject to compliance with requirements, provide products and services by one of the following:

1. GSI Power Systems – Basis of design
2. Thermo Systems
3. Rockwell Automation

## 2.2 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. The Medium Voltage switchgear must be manufactured in accordance with specification 261300 Medium Voltage Switchgear. No exceptions.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for the paralleling switchgear, including clearances between paralleling switchgear and adjacent surfaces and other items. Comply with indicated maximum dimensions.

D. The multiple-generator paralleling monitoring and control panel for the medium voltage switchgear shall monitor and control the following standby power system components:

1. Medium voltage switchgear normal and emergency, all breakers. This includes:
   a. North Switching Station
   b. Howard Hall 15kV Switchgear
   c. Howard Hall Paralleling Switchgear
   d. Peaking Plant Paralleling Switchgear
   e. Capability for expansion to include Future South Switching Station
2. Low Voltage Switchgear, all breakers, including:
   a. Howard Hall 480V Switchgear
   b. Bressler Research Building 480V Switchgear
3. Single-generator monitoring and control system.
4. Single-generator paralleling monitoring and control systems that are incorporated into each individual engine generator.
5. Engine generators.
6. Other load-control devices.

E. The Medium Voltage Switchgear and Low Voltage Switchgear specified includes overcurrent and protective devices. The power system integrator shall provide equipment that meets the Short Circuit and Coordination Study encompassing the entire power system, performed by the engineer of record. The third party testing agency shall test all protective devices and ensure they are set to match the short circuit and coordination study settings for each protective device.

F. The power system Control Sections shall be free standing cabinets listed and labeled UL508A. The Control Section will house the controls inclusive of the PLCs, power supplies, isolation relays etc. for a complete power control system. The Control

Sections shall house all the required control components to meet the specification requirements for a functional system. All communications between control sections, switchgear and other ancillary device locations shall be a dedicated fiber optic self-healing ring.

G. The automation and control system shall facilitate overall paralleling operations including automatic standby operation, monitoring and control of the generator sets including start/stop, alarm/fault monitoring, synchronizing, generator kW load sharing, generator kVAR load sharing, generator loading/unloading, load shed/add, power factor control when in utility paralleling operation, and protective relaying.

H. The automation and controls shall utilize true redundant master PLC based control system. The system shall be a bump less hot swap transfer to the redundant master controller without the loss of control of the power system. Each master control PLC shall be housed in segregated and separate enclosures for fault isolation. Communications shall be via fiber optic communication.

I. The generator paralleling switchgear automation interface shall be via a touchscreen with the following characteristics:
   1. Color, 19" diagonal TFT LCD display capable of displaying both text and graphics.
   2. The display shall support a minimum resolution of 1280x1024 pixels, 16 million displayable colors 24-60kHz horizontal scan rate, 56-75kHz refresh rate.
   3. The touchscreen shall be clear glass with light transmission of 95% or better furnished with a Surface Acoustic Wavetouch interface
   4. The generator paralleling switchgear touchscreen controller shall contain no moving parts.
   5. The Master Control Panel (MCP) and the Switchgear shall have a redundant HMI for full control of the system from any of the control section locations.

J. HMI Screen Listing
   1. The switchgear automation shall provide the following screens. The screens shall provide all of the information, metering, control, annunciations settings and indications listed below:
   2. Main Menu Screen with a complete listing of major screens.
   3. System Overview Screen with animated graphic display of the electrical one line.
   4. Electrical one-line screens for the individual switchgears.
   5. System Control Screen
   6. System Metering Screen.
   7. System Settings Screen.
   8. Generator set control screen for each generator set
   9. Generator set metering screen for each generator set.
   10. Generator set settings Screen
   11. Generator set demand priority control and status screen
   12. Generator set load shed control and status screen

13. Engine monitoring screens for each generator that shall contain a graphical representation of all of the engine gauges and data specified
14. Utility control screen.
15. Utility metering screen
16. Utility setting screen.
17. Password entry screen that shall contain a numeric keypad for password entry
18. Alarm summary screen that shall contain a time/date stamped system alarm summary. Alarm log shall be exportable to external media.
19. Annunciator screens as follows:
20. System annunciation screen that shall contain status, lamp test and alarm points.
21. Generator set annunciator screen for each generator set that shall contain status, lamp test, pre-alarms and shutdown faults.
22. Utility annunciation screen that shall contain status, lamp test and alarm points.
23. Report Menu Screen
24. System settings report
25. Generator set settings report
26. Plant test report – including all current operational parameters
27. Alarm summary report
28. System real time trend screen.
29. Generator set real time trending screens
30. Historical trending package.

## 2.3 SWITCHGEAR AUTOMATION CONTROL FEATURES

A. The generator paralleling switchgear automation and controls shall consist of the hardware and software required for the control of the engine-generator plant and associated utilities, tie, and distribution circuit breakers. The system shall include all automation controllers, HMI (Human Machine Interface) touchscreens, power transducers, supervisory networks and all ancillary control equipment necessary to automatically execute the specified functional sequence of operations.

B. The switchgear control system shall be capable of recognizing when breakers and buses are racked out/unavailable.

C. The switchgear automation and controls shall be provided with an HMI consisting of a touchscreen display located in each control section Listed below:
   1. Master Control Panels (MCP)
   2. Switchgear Control Panels (SCP)
   3. Additional sections as required

D. The HMI shall provide all metering, status, monitoring, and control information to the operator.

E. The HMI shall serve only as an operator interface. The paralleling controls must continue to function normally with a complete HMI failure.

F. The paralleling control automation and controls shall be designed to eliminate single points of failure.

G. For redundancy, multiple PLCs shall be utilized.
   1. At a minimum, the switchgear controls shall utilize a separate controller for each power source i.e. utility, generators and tie breakers.

H. Control systems utilizing a single automation controller are not acceptable.

I. The generator paralleling switchgear automation and controls shall be capable of surviving a fault of one or more of its PLCs. The failure of any generator controller shall only cause loss of automatic operation of a single generator.

J. The paralleling controls shall be provided with redundant communication networks. The communications between the MCP and the Switchgear Control Panel(s) section shall be fiber optic self-healing ring bus

K. The failure of any single master PLC or utility PLC shall in no way hinder the full automatic operation of the entire generator paralleling switchgear automation and control system.

## 2.4 OPERATOR/SYSTEM SAFETY PROVISIONS

A. The Master Control Panel (MCP) shall be located in Howard Hall. The MCP shall contain a Master Auto/Manual (MAM) Switch that disables automated controls for the entire control system. HMI shall display an alarm when MAM switch is placed in Manual.

B. All Local Control Panels (LCPs) shall contain a Station Auto/Manual (SAM) Switch. The SAM switch shall disable automated controls for that station only. HMI shall display an alarm when SAM switch is placed in manual. There shall be SAM switches for the following Switchgear:

   1. Howard Hall 15kV Switchgear (In MCP)
   2. Howard Hall Generator Paralleling Switchgear (In MCP)
   3. Peaking Plant Paralleling Switchgear
   4. North Switching Station
   5. Howard Hall 480V Switchgear (In MCP)
   6. Bressler Research Building 480V Switchgear (In MCP)

C. In addition to the MAM and SAM switches, Local/Remote switches shall be provided. The Local/Remote switches shall prevent any remote control (automated or manually initiated from HMI) of the switchgear from the control system when in “Local”. When Local/Remote switch is in “Local” the HMI shall display an alarm. Switch shall be pad-lockable. The Local/Remote switch shall be located on the switchgear for each specific bus. Provide Local/Remote Switches for the following:
   1. Howard Hall 15kV Switchgear (One L/R Switch for both buses)

2. Howard Hall Generator Paralleling Switchgear (One L/R Switch for both buses)
3. Peaking Plant Paralleling Switchgear (One L/R Switch for both buses)
4. North Switching Station Bus NA
5. North Switching Station Bus NB
6. North Switching Station Bus NC
7. North Switching Station Bus ND
8. Howard Hall 480V Switchgear (One L/R Switch for both buses)
9. Bressler Research Building 480V Switchgear (One L/R Switch for both buses)

D. Return to Utility Inhibit: Provide a software switch that prevents the automatic return to Utility power when the system is on Generators.

2.5 MASTER CONTROL FUNCTIONS

C. Master control redundancy shall be provided by two segregated and redundant automation controllers. One Master Controller shall be located in the MCP with the redundant controller located in a Switchgear Control Panel in close proximity to the MCP. Communications shall be redundant fiber optic communications.

D. Any required transfer of master control functions shall be transparent and concurrent operation with no loss of data on loss or transfer of redundant controllers.

E. Master control functions shall include:

1. Automatic start of the generator plant
2. First-up, dead-bus functions
3. Automatic generator demand priority
4. Load Bank Step Controls
5. Transfer inhibit to emergency/life safety ATS's to remain on life safety generators when campus standby generators are running. Specific ATS's in Howard Hall, Bressler Research Building, and MSTF that require this functionality are called out in the drawings.

F. The system controls shall include a generator demand priority control function to automatically match the on-line generator capacity to the loads, and avoid unnecessary operation of generator sets.

2.6 AUTOMATIC LOAD SHED / ADD

A. The load shed control shall have one essential load shed priority level for each generator in the system plus one non-essential load shed priority level (which is always shed in the emergency mode of operation).

B. The load shed control shall control each of the distribution circuit breakers as shown on the drawings. Distribution circuit breakers to be controlled shall be electrically operated. Each electrically operated distribution circuit breaker shall be field selectable to be assigned to any of the available load shed priority levels. The load shed system

shall include individual breakers in the Medium-Voltage and Low-Voltage Switchgears that are connected to the control system.

C. The Owner shall be able to change the load shed priority of individual loads from the HMI screen.

## 2.7 GENERATOR SET CONTROL FUNCTIONS

A. For safety and availability, all generator set control functions shall be executed autonomously from each generator set PLC controller.

B. No master control coordination or intervention shall be required to affect the generator set control functions.

C. Existing Generator Control Upgrade:
   1. Caterpillar 3508 750KW Engine Generators:
      a. The 2 existing Caterpillar 3508 engine generators located on the roof of building HSF1 shall be retrofitted as described below. The engine generators shall be fully integrated into the new control and automation system. All alarms, available operating parameters and metering functions shall be displayed on the new control and automation HMI's.
      b. The two existing 750 kW Caterpillar 3508 generator sets (serial# 23Z04908 and serial#23Z04905) are located remotely on the roof. The ASCO paralleling controls are located in the basement. The units do not have control panels located on the units. Engine control, voltage regulation and engine governing is accomplished buy a 2301 Woodward load sharing governor and a Basler voltage regulator located in the ASCO switchgear. The generator(s) must operate as a standalone unit capable of full control from a local control cabinet located inside the existing enclosure and full remote control via voltage bias signal, speed bias signal and remote start/stop. The units must have the capability to support a remote annunciator capable of displaying NFPA 11o alarm conditions. The following modifications are required:
         1) Install a Caterpillar EMCP 4.2 controller. This controller must provide engine start/stop and all available engine and generator protection and monitoring. This controller must be capable of communicating to existing SCADA all engine metering, generator metering and alarm conditions via MODBUS 485 and MODBUS TCP/IP.
         2) Replace existing Woodward 2301 Load sharing governor with and updated Woodward 2301 governor capable of controlling engine mounted EPG actuator. The new governor must be located in the new EMCP 4.2 control panel.
         3) Replace existing Basler voltage regulator located in ASCO switchgear with a Caterpillar CDVR. The new CDVR must be located in the new EMCP 4.2 control panel.

2. Cummins Natural Gas Peaking/Standby Plant:

   a. The existing Cummins natural gas 4MW peaking/standby plant shall be fully integrated into the new switchgear control and automation system. The plant shall be supplied with a SCP equipped with a HMI and integrated into the new control and automation system via fiber optic self-healing ring bus. The new control and automation system shall control the Cummins units for speed, voltage, synchronization, and paralleling functions. All alarms, metering and engine parameters shall be displayed on the new control and automation system wide HMI network.

3. Cummins Diesel 1100KW and 1500KW (480VAC generators)

   a. The existing Cummins diesel engine generators located on the roof of the Howard Hall building shall be retrofitted to be independently controlled by the new control and automation system for paralleling.

## 2.8 SYSTEM MASTER I/O

A. System master I/O shall be fully redundant, including horn, horn silence, instant auto selector, load shed on/off, and load shed relays

B. Transfers from primary to back-up system master I/O shall be transparent and bumpless.

C. Load Shed / Load Add Distribution Circuit Breaker I/O

D. Load shed / load add I/O shall be monitored and controlled via the supervisory network.

E. Load shed / load add distribution circuit breaker I/O shall include:

F. Circuit breaker auxiliary contact monitoring

G. Circuit breaker bell alarm contact monitoring

H. Close circuit breaker output

I. Open circuit breaker output

## 2.9 LOAD SHED / LOAD ADD DISTRIBUTION CIRCUIT BREAKER I/O REDUNDANCY

A. Load shed / load add I/O shall be fully redundant.

B. Transfers from primary to back-up load shed / load add I/O shall be transparent and concurrent operation with no loss of data on loss or transfer of redundant controllers.

## 2.10 SUPERVISORY NETWORK

A. The supervisory network shall consist of a non-proprietary topology and utilize open source protocols.

B. Supervisory network topology shall be EMI and RFI noise tolerant.

C. Supervisory network data rate shall be a minimum of 10Mbps.

D. All critical plant control data communication shall be deterministic with an update rate not to exceed 100ms.

E. The supervisory network shall be a fully dedicated network, providing high speed communication for the following:
   1. Communications of control data between distributed controllers
   2. Distribution of master control data
   3. Communications to and from the system HMI(s)
   4. Communications to and from the customer building management / BAS Interface.
   5. Communication to and from 3rd party balance of plant PLCs (as specified)
   6. Transfers from the primary to the back-up supervisory network shall be transparent and concurrent operation with no loss of data on loss or transfer of redundant controllers.

## 2.11 CONTROL POWER REDUNDANCY

A. Paralleling controls automation control power system shall be protected against single point of failure by the utilization of a 125Vdc, best source DC system strategy. Each switchgear lineup control power system shall include the following features:
   1. Paralleling Switchgear and MCP
      a. The best source DC bus shall accept 125Vdc, through an isolation diode and circuit breaker, from each generator set battery.
   2. All control automation and controls shall be powered directly from this best source DC bus for each control panel.

## 2.12 ALARM LOG

A. The switchgear automation shall log all events and alarms with device, condition, and time/date stamp.

B. The system alarms inclusive of the automation and controls, protective relays HMI's and other devices shall be synchronized with the use of a GPS clock for fault analysis.

2.13 REAL TIME TRENDING

A. The switchgear automation shall support real time trending.

B. Real time trending shall display the following:
   1. Utility:
      a. Average voltage, average current, kW, kVAR.
   2. For each system generator set:
      a. Voltage, amps per phase, kW, kVAR, frequency, engine RPM, engine battery voltage, engine oil pressure, engine water temperature.

2.14 LONG TERM HISTORICAL TRENDING

A. Long term historical trending shall log switchgear data in non-volatile memory. This data shall be displayed in a strip chart format. Historical data file format shall be Microsoft compatible to facilitate manipulation of these files in other software programs.

2.15 MANUAL CONTROLS

A. Full manual backup control shall be provided for generator set voltage and frequency control.

B. Each power source breaker shall be provided with manual synchronizing scopes and associated (25) sync-check protective relays. The synchronizing scopes may be displayed on each HMI for all sources on the system on individual screens for each source. Software protective relays are not acceptable for manual operation functions.

C. Manual operation at the minimum shall allow a single generator to be placed on the bus and to carry the facility loads on a single engine generator up to the engine generator capacity. Each generator shall have the capability to be manually placed on the bus.

D. Demonstrate to the facility personnel the capability to manually control an engine generator without the use of the automation system.

2.16 SYSTEM METERING

C. The following metering information shall be displayed on the HMI for the system bus, each individual utility, tie, generator, and distribution breaker:
   1. Volts with 4-position selector switch to select three phases of voltage
   2. Amps with 4-position selector switch
   3. Kilowatts
   4. Kilovars
   5. Frequency

6. Power Factor

D. All engine parameter data available on the generator set shall be accessible on the HMI.

## 2.17 PARALLELING SYSTEM ANNUNCIATION

A. The MCP's and SCP's shall be provided with local annunciation to monitor and display critical generator set, utility, and system status, fault, and shutdown information.

B. Annunciation shall comply with NFPA 110 requirements.

C. The annunciation system shall be equipped with a fast pulse horn (rated 80-95 dba at two feet), a horn silence push-button and an "Acknowledge" push-button. Any generator pre-alarm, generator shutdown alarm, or generator paralleling switchgear alarm shall cause the alarm horn to sound until the horn silence button is depressed. Any subsequent alarms shall re-sound the horn. The display shall operate such that any alarm point shall "flash" until acknowledged.

D. The annunciation system shall be provided with five (5) distinct types of annunciation points:
   1. Status Points – These annunciation points shall show the status of critical system or generator set components. Status annunciation points shall not sound the annunciation system horn. They shall not require acknowledgement.
   2. Generator Set Pre-Alarm Points – These annunciation points shall show fault conditions that could jeopardize the ability of the generator paralleling switchgear to function properly without immediate attention. Generator set pre-alarm annunciation points shall sound the annunciation system horn. They shall require acknowledgement. Generator set pre-alarm annunciation points shall reset automatically as the alarm condition is cleared.
   3. Generator Set Shutdown Alarm Points - These annunciation points shall show fault conditions that have caused the shutdown of one (1) or more generator sets. Generator set shutdown annunciation points shall sound the annunciation system horn. They shall require acknowledgement. Generator set shutdown annunciation points shall cause the generator set to shut down and the generator main to trip open. The generator main is then locked out until the cause of the shutdown is corrected, the engine control switch is placed in Off/Reset, and then placed back in Auto or Manual position.
   4. Utility Alarm Points – These annunciation points will indicate utility related fault conditions. Utility annunciation points shall sound the annunciation system horn. They shall require acknowledgement.
   5. Generator paralleling switchgear Alarm Points – These annunciation points will indicate system wide fault conditions. The generator paralleling switchgear

annunciation points shall sound the annunciation system horn. They shall require acknowledgement.

2.18 SEQUENCE OF OPERATION:

A. Load Shed/Add Control Logic

The System Controls shall include a Load Shed Control function to control the loads served by the generator plant. The Load Shed Control shall have one Essential Load Shed Priority Level for each generator in the system plus one Non-Essential Load Shed Priority Level (which is always shed in the Emergency Mode of operation).

The Load Shed Control shall control each of the distribution circuit breakers within the medium voltage switchgear and low voltage substations. Each electrically operated distribution circuit breaker shall be field selectable to be assigned to any of the available Load Shed Priority Levels. Additionally, Load Shed Control shall provide a 4 pole, 10A, 120VAC rated, form C set of contacts for each Load Shed Priority Level to allow for control of loads external to the switchgear.

The following controls shall be provided for each level:

a. Shed Delay Timer, adjustable from 0 to 1024 seconds
b. Add Delay Timer, adjustable from 0 to 1024 seconds
c. Load Shed Override Selector (shed/auto//add)
d. Status indicators to show whether the Priority Level is Added or Shed

The Load Shed Controls shall have:

a. Load Shed Control Switch (On/Off)
b. User-settable Load Shed % (as a function of on-line generator capacity)
c. User-settable Load Add % (as a function of on-line generator capacity)
d. User-settable Bus Under frequency Set point
e. User-settable Bus Under frequency time delay
f. Bus Under frequency Reset Pushbutton
g. Bus Under frequency indicator

Conditional Load Shed: Upon entrance into Emergency Mode of operation, the Load Shed Control shall shed all Essential and Non-Essential loads. As generators come to the bus, Essential Priority Level loads shall be added conditionally based on the number of generators on line. When the first generator comes to the bus, Priority Level 1 loads shall be added; Second generator, priority 2, etc. After a time delay that allows all operational generators to come to the bus, Load Shed Mode shall shift to Load Sensitive Mode.

Load Sensitive Load Shed – After all generators have been given sufficient time to come to the bus, load shed shall shift to “Load Sensitive” mode. The system shall compare cur-

rent generator on-line capacity (in kW) to current load requirements. If surplus capacity is greater than the calculated Load Add setpoint, after the Load Add Time Delay the next Load Shed Priority will be added. This calculation will continue until all Sheddable Loads are added, or until surplus capacity is less than the calculated Load Add setpoint. If surplus capacity is less than the calculated Load Shed setpoint, after the Load Shed Time Delay the next Load Shed Priority will be shed. This calculation will continue until all Sheddable Loads are shed, or until surplus capacity is greater than the calculated Load Shed setpoint. The Load Shed Control, in its automatic shedding and adding of loads, shall not override any manual load shed/add operation.

Should the load bus frequency fall below the user selected bus underfrequency setpoint for a period longer than the bus underfrequency time delay, then all Priority Level loads shall be shed and load addition shall not resume until the operator has depressed the Bus Underfrequency Reset button. The bus underfrequency protection shall override any manual load add operation.

B. Generator Demand Priority Control

The System Controls shall include a Generator Demand Priority Control function to automatically match the on-line generator capacity to the loads to avoid unnecessary operation of all the generators when the loads are low.

The following controls shall be provided for each generator:

a. User-settable Generator Priority Selector
b. Status indicator for the Generator Priority Selected
c. Status indicator for generator On-line or Off-line

The Generator Demand Priority Control shall have the following controls:

a. Generator Demand Priority Control Switch (On/Off)
b. User-settable Generator Remove % (as a function of a single generator capacity)
c. User-settable Generator Remove Delay
d. User-settable Generator Add % (as a function of a single generator capacity)
e. User-settable Generator Add Delay

Upon entrance into Emergency or Load Management modes, all generators shall be started and paralleled to the bus. After the Remove Time Delay, generators shall be removed from the bus as a function of the generator percentage loading by the user selected Generator Remove time delay. Generators shall be removed from the bus in descending priority. Should the generator percentage loading increase to the user selected Generator Add limits for the user selected Add Delay, the next generator will be started, synchronized and paralleled to the bus. Generators shall be added to the bus in ascending priority order. Should the generator plant ever reach 95% loading, the next priority generator shall be started and added to the bus with no time delay.

C. Load Management Mode – Demand Response
   1. Entry
      a. The BAS system will send a signal to the switchgear control system to enter demand response mode and start the generators. Under this project, the contractor shall provide the hardwired points from the BAS system to start the generators. A future project will incorporate the signals into the BAS system.
      b. A run request is sent to the generator plant natural gas generators and the diesel engine generators equipped with SCR's for operation during Demand Response.
      c. The generators are allowed to run for a five-minute warm-up time (which can be abbreviated by the operator).
      d. After completion of the warm-up time the first generator up to rated voltage and frequency is closed to the HH 15KV Generator Switchgear load bus. The automation dead bus logic will prevent 2 source breakers attempting to close onto the bus simultaneously.
      e. The remaining HH 15KV generators are synchronized and paralleled to the HH 15KV Generator bus as they reach rated voltage and frequency. The Peaking Plant will concurrently start and synchronize its engine generators to the 15KV Peaking Plant load bus. After all Demand Response compliant generators are on the load bus or the expiration of the adjustable fail to synchronizing timer, factory set at 2 minutes the Peaking Plant will synchronize to the HH 15KV Generator Switchgear load bus and close the priority paralleling breaker G2 in the HH 15KV Generator Switchgear.
      f. The generator plant is soft ramp loaded until it is serving nominally the required amount of the load on the bus to meet the mode of operation selected.
      g. The generator output is dynamically adjusted to maintain the set point to meet the mode of operation selected.
      h. Should the utility fail at any time during Load Management operation, the utility protective relays shall cause the utility mains to open and be locked out, thus placing the system in Emergency Mode until the Utility is restored (as described in Emergency Mode exit).
   2. Exit
      a. The operator removes the Master Mode Selector Switch from Load Management position and returns it to the Auto position.
      b. The generator plant is soft ramp unloaded until the utility source is nominally serving the facility loads.
      c. The 15KV Generator Emergency tie breakers HNA and HNB are opened by the automation logic at the user adjustable KW disconnect set point, factory set at 100KW.
      d. Peaking Plant Tie breaker G2 located in HH 15KV Generator Switchgear is opened.
      e. All generator main paralleling breakers are opened.
      f. The generators are allowed to run for their programmed cool down period.
      g. The system is now back in Automatic/Standby Mode.

## 2.19 SOURCE QUALITY CONTROL

A. Simulated System Testing: Before the Electrical Power Monitoring and Control system is implemented, demonstrate a simulated system to the Owner and Owner's

representative. The simulated system shall include a virtual single line showing all switchgear, breakers, and generators. The programming for the Sequence of Operation as described in specification 261302 shall be included. Manual and Automatic control of the system shall be demonstrated to show a complete working control system. Submit testing plan a minimum of 4 weeks before factory testing.

B. Testing: Test and inspect switchgear controls at switchgear manufacturer's factory.

1. Switchgear:
   a. Switchgear and Control manufacturer to Provide Factory Witness test scripts to the owner 12 weeks after release of order for manufacture for evaluation and comment.
   b. Factory test with simulated inputs. Test control and relay functions for proper operation.
   c. Perform a complete sequence of operations test with failure scenarios.

C. Switchgear controls, will be considered defective if it does not pass tests and inspections.

D. Coordinate scheduling of the factory witness test with the Owner. Perform Fcatory Witness Test successfully prior to customer witness test.

E. Schedule Customer Witness test for owner 2 weeks prior to scheduled shipment. Include cost of the Factory Witness Test, Customer Witness Test airfare and Hotel accommodations for the Owner and (4) Owner reps

F. Prepare test and inspection reports.

G. Owner will witness all required factory tests. Contractor to provide accommodations if more than 50 mi from site. Notify Owner at least 14 days before date of tests and indicate their approximate duration.
   1. Attendance or non-attendance by the Owner and/or their duly authorized representatives at factory tests shall not relieve the manufacturer of responsibility to correct any defects or items of non-conformance with these specifications discovered during site testing.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, where paralleling switchgear will be installed for compliance with installation tolerances, required clearances, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Section 260553 "Identification for Electrical Systems."

B. Diagrams and Instructions:

1. Frame and mount under clear acrylic plastic on front of paralleling switchgear.

a. Operating Instructions: Printed basic instructions for paralleling switchgear, including control and interlock sequences and emergency procedures.
b. System Power Riser Diagrams: Depict power sources, feeders, distribution components, and major loads.

2. Storage for Maintenance: Include a rack or holder, near the operating instructions, for a copy of maintenance manual.

3.3 CONNECTIONS

A. Comply with grounding and bonding requirements in Section 260526"Grounding and Bonding for Electrical Systems."

3.4 FIELD QUALITY CONTROL TESTING,

A. Factory Witness Testing: The Owner reserves the right to inspect the equipment at equipment manufacturing facility for conformance with this specification prior to shipment. The Vendor shall notify the Owner in writing at least 14 working days prior to commencement of factory tests to permit the Owner the option of witnessing such tests. Under no condition will the equipment be released for shipment without prior notice of factory tests and witness test or waiver by the Owner. All re-tests due to improper notice or test failure shall be conducted, as required, at the Vendor's expense.

1. Release by the Owner to ship, or waiver of inspection or test witnessing in no way shall relieve the Vendor of responsibility for the equipment being in conformance with this specification and applicable standards.
2. Any material or equipment contained therein which, upon inspection, are found to contain defects, shipping damage, improper construction, excessive repairs, used parts, or not in accordance with this specification are subject to rejection by the Owner. The Owner reserves the right of rejection at the job site if the above conditions are discovered even after factory acceptance.
3. In general, the Vendor shall perform all tests on the switchgear as required to verify the proper operation of each component and controls. A recommended factory test procedure shall be provided by the Switchgear Vendor and approved by the Owner.

4. The control logic shall fully demonstrate the sequence of operation to the satisfaction of the owner and/or the owner's representatives.
5. The FWT shall include single point of failure testing for conformance to the specifications.
6. Vendor to include full cost for four individuals to witness testing cost to include travel, hotel, meals and local transportation.

B. Site Tests: Prior notification of all site tests shall be required. Site tests shall be witnessed by the Owner's representative. Scheduling of site tests shall be coordinated with the Owner's prior to startup. Prepare for acceptance tests as follows:

1. Test insulation resistance for each switchgear bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.
3. Similar to the factory witness test, the vendor shall provide a demonstration of the control logic to fully demonstrate the sequence of operation to the satisfaction of the owner and/or the owner's representatives prior to commissioning. Provide 4 weeks' notice prior to test.
4. Conduct tests for reconditioned generators. Verify controller functionality.

C. Testing Agency: Engage a qualified, NETA certified testing agency to perform tests and inspections.

D. Prepare test and inspection reports.

E. Test sequence of operation step by step for each mode.

## 3.5 CLEANING

A. On completion of installation, inspect interior and exterior of paralleling switchgear. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair damaged finishes.

## 3.6 PROTECTION

A. Temporary Heating: Apply temporary heat to paralleling switchgear, according to manufacturer's written instructions, throughout periods when paralleling switchgear environment is not controlled for temperature and humidity within manufacturer's stipulated service conditions.

## 3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain paralleling switchgear and controls.

B. Training shall include 4 hours of classroom instruction and 8 hours of hands on instruction. Training shall be digitally recorded for the owner.

C. An additional training session shall be held with the Owner 6 months after the initial training session. Training shall include 8 hours of hands on training. The Owner shall submit to the trainer 1 month prior to training a list of questions and or topics to be addresses during this training session.

END OF SECTION 262313

# SECTION 262413 - SWITCHBOARDS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 26.

### 1.2 SUMMARY

A. Section Includes:

1. Service and distribution switchboards rated 600 V and less.
2. Disconnecting and overcurrent protective devices.
3. Instrumentation.
4. Control power.
5. Accessory components and features.
6. Identification.

### 1.3 SUBMITTALS

A. Product Data: For each type of switchboard, overcurrent protective device, transient voltage suppression device, ground-fault protector, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

B. Shop Drawings: For each switchboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types for types other than NEMA 250, Type 1.
3. Detail bus configuration, current, and voltage ratings.
4. Detail short-circuits current rating of switchboards and overcurrent protective devices.
5. Include descriptive documentation of optional barriers specified for electrical insulation and isolation.
6. Detail utility company's metering provisions with indication of approval by utility company.

7. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
8. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Include selectable ranges for each type of overcurrent protective device.

9. Include schematic and wiring diagrams for power, signal, and control wiring.

C. Qualification Data: For qualified testing agency.

D. Field Quality-Control Reports:

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

E. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Routine maintenance requirements for switchboards and all installed components.
2. Manufacturer's written instructions for testing, maintaining and adjusting overcurrent protective devices.
3. Time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Include selectable ranges for each type of overcurrent protective device.

## 1.4 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.

B. Testing Agency Qualifications: Member Company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

C. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

D. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

F. Comply with NEMA PB 2.

G. Comply with NFPA 70.

H. Comply with UL 891.

## 1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.

B. Remove loose packing and flammable materials from inside switchboards and [install temporary electric heating (250 W per section) to prevent condensation.

C. Handle and prepare switchboards for installation according to NEMA PB 2.1.

## 1.6 PROJECT CONDITIONS

A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.

B. Environmental Limitations:

1. Do not deliver or install switchboards until spaces are enclosed and weather-tight, wet work in spaces is complete and dry, work above switchboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:

    a. Ambient Temperature: Not exceeding $104^0$F ($40^0$C).
    b. Altitude: Not exceeding 6600 feet (2000 m).

C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify UMB, in writing, no fewer than 10 days in advance of proposed interruption of electric service.

2. Indicate method of providing temporary electric service.
3. Do not proceed with interruption of electric service without UMB's written permission.
4. Comply with NFPA 70E.

## 1.7 COORDINATION

A. Coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

## 1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

## 1.9 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Potential Transformer Fuses: Equal to 10% of quantity installed for each size and type, but no fewer than two (2) of each size and type.
2. Control-Power Fuses: Equal to 10 % of quantity installed for each size and type, but no fewer than two (2) of each size and type.
3. Fuses and Fusible Devices for Fused Circuit Breakers: Equal to 10 % of quantity installed for each size and type, but no fewer than three (3) of each size and type.
4. Fuses for Fused Switches: Equal to 10 % of quantity installed for each size and type, but no fewer than three (3) of each size and type.
5. Fuses for Fused Power-Circuit Devices: Equal to 10 % of quantity installed for each size and type, but no fewer than three (3) of each size and type.
6. Indicating Lights: Equal to 10 % of quantity installed for each size and type, but no less than one of each size and type.
7. Provide Fuse cabinet, to location coordinated with Owner.

1.10 WARRANTY/GUARANTEE

A. See Division 26 Specification Section "Basic Electrical Requirements' for warranty and guarantee requirements.

## PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. Siemens Energy & Automation, Inc.
3. Square D; a brand of Schneider Electric.

B. Front- and Side-Accessible Switchboards:

1. Main Devices: Fixed, individually mounted.
2. Branch Devices: Panel mounted.
3. Sections front and rear aligned.

C. Nominal System Voltage: 480Y/277 V.

D. Main-Bus Continuous: 400 A.

E. Indoor Enclosures: Steel, NEMA 250, Type 1.

F. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's ANSI 49 gray finish over a rust-inhibiting primer on treated metal surface.

G. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.

H. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.

I. Buses and Connections: Three-phase, four-wire unless otherwise indicated.

1. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity, with copper feeder circuit-breaker line connections.
2. Ground Bus: 1/4-by-2-inch hard-drawn copper of 98 % conductivity, equipped with mechanical connectors for feeder and branch-circuit ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.
3. Main Phase Buses and Equipment Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.

4. Neutral Buses: 100 % of the ampacity of phase buses unless otherwise indicated, equipped with mechanical connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.

J. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

## 2.2 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
   1. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:

      a. Instantaneous trip.
      b. Long- and short-time pickup levels.
      c. Long- and short-time time adjustments.
      d. Ground-fault pickup level, time delay, and $I^2t$ response.

## 2.3 INSTRUMENTATION – Refer to Section 262713 “Electricity Metering” & 260913 “Electrical Power Monitoring & Control”

## 2.4 CONTROL POWER

A. Control Circuits: 120-V ac, supplied through secondary disconnecting devices from control-power transformer.

B. Control-Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.

C. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

## 2.5 IDENTIFICATION

A. Service Equipment Label: NRTL labeled for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.

B. Permanent Engraved Phenolic Nameplates: Provide white with black lettering ID plates for each circuit.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Receive, inspect, handle, and store switchboards according to NEMA PB 2.1.

B. Examine switchboards before installation. Reject switchboards that are moisture damaged or physically damaged.

C. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

A. Install switchboards and accessories according to NEMA PB 2.1.

B. Equipment Mounting: Install switchboards on concrete base, four (4) inch (100-mm) nominal thickness. Comply with requirements for concrete base specified in Division 03 Section "Cast-in-Place Concrete."

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on eighteen (18) inch (450-mm) centers around the full perimeter of concrete base.
2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to switchboards.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.

D. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.

E. Install filler plates in unused spaces of panel-mounted sections.

F. Install overcurrent protective devices, transient voltage suppression devices, and instrumentation.

G. Comply with NECA 1.

## 3.3 CONNECTIONS

A. Comply with requirements for terminating feeder bus specified in Division 26 Section "Enclosed Bus Assemblies." Drawings indicate general arrangement of bus, fittings, and specialties.

B. Comply with requirements for terminating cable trays specified in Division 26 Section "Cable Trays for Electrical Systems." Drawings indicate general arrangement of cable trays, fittings, and specialties.

## 3.4 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

## 3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Acceptance Testing Preparation:

1. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

D. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:

    a. Initial Infrared Scanning: After Substantial Completion, but not more than sixty (60) days after Final Acceptance, perform an infrared scan of each switchboard. Remove front and side panels so joints and connections are accessible to portable scanner.
    b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchboard eighteen (18) months after date of Substantial Completion.
    c. Instruments and Equipment:

        1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
    d. Follow NFPA 70E requirements

4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

E. Switchboard will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken and observations after remedial action.

## 3.6 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Overcurrent Protective Device Coordination Study."

## 3.7 PROTECTION

A. Temporary Heating: Apply temporary heat, to maintain temperature according to manufacturer's written instructions, until switchboard is ready to be energized and placed into service.

END OF SECTION 262413

# SECTION 262416 - PANELBOARDS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 26.

### 1.2 SUMMARY

A. Section Includes:

1. Distribution panelboards.
2. Lighting and appliance branch-circuit panelboards.

### 1.3 DEFINITIONS

A. SVR: Suppressed voltage rating.

B. TVSS: Transient voltage surge suppressor.

### 1.4 PERFORMANCE REQUIREMENTS

### 1.5 SUBMITTALS

A. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types and details for types other than NEMA 250, Type 1.
3. Detail bus configuration, current, and voltage ratings.
4. Short-circuit current rating of panelboards and overcurrent protective devices.
5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

6. Include wiring diagrams for power, signal, and control wiring.
7. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Also include selectable ranges for each type of overcurrent protective device.

C. Qualification Data: For qualified testing agency.

D. Field Quality-Control Reports:

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

E. Panelboard Schedules: For installation in panel boards. Submit final versions after load balancing.

F. Operation and Maintenance Data: For panel boards, and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for maintaining, testing and adjusting overcurrent protective devices.
2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

## 1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Comply with NEMA PB 1.

F. Comply with NFPA 70.

## 1.7 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.

B. Handle and prepare panelboards for installation according to NEMA PB 1.

## 1.8 PROJECT CONDITIONS

A. Environmental Limitations:

1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:

    a. Ambient Temperature: Not exceeding $23^0$F to plus $104^0$F.
    b. Altitude: Not exceeding 6600 feet.

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:

1. Ambient temperatures within limits specified.
2. Altitude not exceeding 6600 feet.

C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify UM, in writing, no fewer than 10 days in advance of proposed interruption of electric service.
2. Do not proceed with interruption of electric service without UM's written permission.
3. Comply with NFPA 70E.

## 1.9 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other

types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

## 1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

## 1.11 EXTRA MATERIALS

A. Revise this article to include extra materials that Owner may require, such as GFCI or GFEP circuit breakers or circuit breakers used for switching service, which may fail more frequently due to continuous use.

B. Coordinate with Division 26 Section "Fuses" for quantities of spare fuses and spare-fuse cabinet to be provided.

C. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Keys: Two spares for each type of panelboard cabinet lock.
2. Circuit Breakers Including GFCI and Ground Fault Equipment Protection (GFEP) Types: Twospares for each panelboard.
3. Fuses for Fused Switches: Equal to 10 % of quantity installed for each size and type, but no fewer than three (3) of each size and type.
4. Fuses for Fused Power-Circuit Devices: Equal to 10 % of quantity installed for each size and type, but no fewer than three (3) of each size and type.
5. Provide and install fuse cabinet.

## 1.12 WARRANTY/GUARANTEE

A. See Division 26 Specification Section “Basic Electrical Requirements’ for warranty and guarantee requirements.

## PART 2 - PRODUCTS

### 2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

A. Enclosures: Surface-mounted cabinets.

1. Rated for environmental conditions at installed location.

   a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
   b. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

2. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
3. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
4. Finishes:

   a. Panels and Trim: Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two (2) coat, baked-on finish consisting of prime coat and thermosetting topcoat.
   b. Back Boxes: Galvanized steel.

5. Directory Card: Inside panelboard door, mounted in transparent card holder.

B. Incoming Mains Location: Top or bottom fed as needed

C. Phase, Neutral, and Ground Buses:

1. Material: Hard-drawn copper, 98 % conductivity.
2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
3. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.
4. Extra-Capacity Neutral Bus: Neutral bus rated 200 % of phase bus and UL listed as suitable for nonlinear loads.

D. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Hard-drawn copper, 98 % conductivity.
2. Main and Neutral Lugs: Mechanical type.
3. Ground Lugs and Bus-Configured Terminators: Mechanical type.
4. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
5. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device as needed.

6. Gutter-Tap Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
7. Extra-Capacity Neutral Lugs: Rated 200 % of phase lugs mounted on extra-capacity neutral bus.

E. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.

F. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

G. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

## 2.2 DISTRIBUTION PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

B. Panelboards: NEMA PB 1, power and feeder distribution type.

C. Mains: Circuit Breaker

D. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Plug in circuit breakers.

E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

F. Breaker Spaces: Provide 99” of available breaker space.

## 2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

C. Mains: Circuit breaker or main lugs only as designated on contract drawings.

D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

E. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

## 2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. Siemens Energy & Automation, Inc.
3. Square D; a brand of Schneider Electric.

B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:

    a. Instantaneous trip.
    b. Long- and short-time pickup levels.
    c. Long- and short-time time adjustments.
    d. Ground-fault pickup level, time delay, and $I^2t$ response.
4. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
5. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:

    a. Standard frame sizes, trip ratings, and number of poles.
    b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.

c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
e. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in off position.
f. Handle Clamp: Loose attachment for holding circuit-breaker handle in on position.

2.5 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

B. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.

B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.

C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install panelboards and accessories according to NEMA PB 1.1.

B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

C. Mount top of trim 90 inches above finished floor unless otherwise indicated.

D. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

E. Install overcurrent protective devices and controllers not already factory installed.

1. Set field-adjustable, circuit-breaker trip ranges.

F. Install filler plates in unused spaces.

G. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

H. Comply with NECA 1.

## 3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

## 3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

D. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:

    a. Initial Infrared Scanning: After Substantial Completion, but not more than sixty (60) days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
    b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard eleven (11) months after date of Substantial Completion.
    c. Instruments and Equipment:

        1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

4. Comply with NFPA 70E.

E. Panelboards will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken and observations after remedial action.

## 3.5 ADJUSTING

A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Overcurrent Protective Device Coordination Study."

C. Load Balancing: After Substantial Completion, but not more than sixty (60) days after Final Acceptance, measure load balancing and make circuit changes.

1. Measure as directed during period of normal system loading.

2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical twenty four (24) hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
4. Tolerance: Difference exceeding 20 % between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

## 3.6 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION 262416

# SECTION 262726 - WIRING DEVICES

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 26.

### 1.2 SUMMARY

A. This Section includes the following:

1. Receptacles, receptacles with integral GFCI, and associated device plates.
2. Snap switches and wall-box dimmers.
3. Wall-switch and exterior occupancy sensors.

B. GFCI: Ground-fault circuit interrupter.

C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

D. RFI: Radio-frequency interference.

E. TVSS: Transient voltage surge suppressor.

### 1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70, “National Electrical Code”.

1.5 COORDINATION

A. Receptacles for Owner-Furnished Equipment: Match plug configurations.

1. Cord and Plug Sets: Match equipment requirements.

1.6 WARRANTY/GUARANTEE

A. See Division 26 Specification Section “Basic Electrical Requirements’ for warranty and guarantee requirements.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:

1. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).
2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
3. Leviton Mfg. Company Inc. (Leviton).
4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

2.2 STRAIGHT BLADE RECEPTACLES

A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.

1. Products: Subject to compliance with requirements, provide one (1) of the following:

a. Cooper; 5351 (single), 5352 (duplex).
b. Hubbell; HBL5351 (single), CR5352 (duplex).
c. Leviton; 5891 (single), 5352 (duplex).
d. Pass & Seymour; 5381 (single), 5352 (duplex).

## 2.3 GFCI RECEPTACLES

A. General Description: Straight blade, feed-through type. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped.

B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:
1. Products: Subject to compliance with requirements, provide one (1) of the following:

a. Cooper; XGF20.
b. Pass & Seymour; 2095.

## 2.4 SNAP SWITCHES

A. Comply with NEMA WD 1 and UL 20.

B. Switches, 120/277 V, 20 A:

1. Products: Subject to compliance with requirements, provide one (1) of the following:

a. Cooper; 2221 (single pole), 2222 (two pole), 2223 (three way), 2224 (four way).
b. Hubbell; CS1221 (single pole), CS1222 (two pole), CS1223 (three way), CS1224 (four way).
c. Leviton; 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way), 1224-2 (four way).
d. Pass & Seymour; PS20AC1 (single pole), PS20AC2 (two pole), PS20AC3 (three way), 20AC4 (four way).

C. Pilot Light Switches, 20 A:
1. Products: Subject to compliance with requirements, provide one (1) of the following:

a. Cooper; 2221PL for 120 V and 277 V.
b. Hubbell; HPL1221PL for 120 V and 277 V.
c. Leviton; 1221-PLR for 120 V, 1221-7PLR for 277 V.
d. Pass & Seymour; PS20AC1-PLR for 120 V.

2. Description: Single pole, with neon-lighted handle, illuminated when switch is "ON."

D. Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors.
1. Products: Subject to compliance with requirements, provide one (1) of the following:

a. Cooper; 1995.
b. Hubbell; HBL1557.
c. Leviton; 1257.
d. Pass & Seymour; 1251.

2.5 INDOOR OCCUPANCY SENSORS

A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. Hubbell Lighting.
2. Leviton Mfg. Company Inc.
3. Lithonia Lighting; Acuity Lighting Group, Inc.
4. Novitas, Inc.
5. Sensor Switch, Inc.
6. TORK.
7. Watt Stopper (The).

B. General Description: Wall- or ceiling-mounting, solid-state units with a separate relay unit.

1. Operation: Unless otherwise indicated, turn lights on when covered area is occupied and off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of one (1) minute to fifteen (15) minutes.
2. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.
3. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, and Class 2 power source as defined by NFPA 70.
4. Mounting:

a. Sensor: Suitable for mounting in any position on a standard outlet box.
b. Relay: Externally mounted through a one half (1/2) inch knockout in a standard electrical enclosure.
c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.

5. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.
6. Bypass Switch: Override the on function in case of sensor failure.
7. Automatic Light-Level Sensor: Adjustable from two (2) fc to two hundred (200) fc; keep lighting off when selected lighting level is present.
8. Auxiliary Contacts: Ceiling mounted occupancy sensors shall have two sets of dry contacts.

C. Ultrasonic Type: Ceiling mounting; detect occupancy by sensing a change in pattern of reflected ultrasonic energy in area of coverage. Operating frequency shall be 40K hertz or higher.

1. Detector Sensitivity: Detect a person of average size and weight moving not less than twelve (12) inches in either a horizontal or a vertical manner at an approximate speed of twelve (12) inches/s.
2. Detection Coverage (Small Room): Detect occupancy anywhere within a circular area of six hundred (600) sq. ft. when mounted on a ninety six (96) inch-high ceiling.
3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of one thousand (1,000) sq. ft. when mounted on a ninety six (96) inch-high ceiling.
4. Detection Coverage (Large Room): Detect occupancy anywhere within a circular area of two thousand (2,000) sq. ft. when mounted on a ninety six (96) inch-high ceiling.
5. Detection Coverage (Corridor): Detect occupancy anywhere within ninety (90) feet when mounted on a ten (10) foot-high ceiling in a corridor not wider than fourteen (14) feet.

D. Dual-Technology Type: Ceiling mounting; detect occupancy by using a combination of PIR and ultrasonic detection methods in area of coverage. Particular technology or combination of technologies that controls on-off functions shall be selectable in the field by operating controls on unit.

1. Sensitivity Adjustment: Separate for each sensing technology.
2. Detector Sensitivity: Detect occurrences of six (6) inch-minimum movement of any portion of a human body that presents a target of not less than thirty six (36) sq. in., and detect a person of average size and weight moving not less than twelve (12) inches in either a horizontal or a vertical manner at an approximate speed of twelve (12) inches/s.
3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of one thousand (1,000) sq. ft. when mounted on a ninety six (96) inch-high ceiling.

2.6 WALL PLATES

A. Single and combination types to match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Material for Finished Spaces0.035-inch- thick, satin-finished stainless steel.
3. Material for Unfinished Spaces: Smooth, high-impact thermoplastic.
4. Material for Damp Locations: Thermoplastic with spring-loaded lift cover, and listed and labeled for use in "wet locations."

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with type 3R weather-resistant thermoplastic with lockable cover.

2.7 FINISHES

A. Color: Wiring device catalog numbers in Section Text do not designate device color.

1. Wiring Devices Connected to Normal Power System: White, unless otherwise indicated or required by NFPA 70 or device listing.
2. Wiring Devices Connected to Emergency Power System: Red.

**PART 3 - EXECUTION**

3.1 INSTALLATION

A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.

B. Coordination with Other Trades:

1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.
2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.

2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
4. Existing Conductors:

    a. Cut back and pigtail, or replace all damaged conductors.
    b. Straighten conductors that remain and remove corrosion and foreign matter.
    c. Pigtailing existing conductors is permitted provided the outlet box is large enough.

D. Device Installation:

1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the right.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Dimmers:

1. Install dimmers within terms of their listing.
2. Verify that dimmers used for fan speed control are listed for that application.

3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.

H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

I. Occupancy Sensors: Unless otherwise indicated on contract drawings, all sensors shall be dual technology type.

J. Adjust locations of floor service outlets and power poles to suit arrangement of partitions and furnishings.

## 3.2 IDENTIFICATION

A. Comply with Division 26 Section "Identification for Electrical Systems."

## 3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. In healthcare facilities, prepare reports that comply with recommendations in NFPA 99.
2. Test Instruments: Use instruments that comply with UL 1436.
3. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.

B. Tests for Convenience Receptacles:

1. Line Voltage: Acceptable range is 105 to 132 V.
2. Percent Voltage Drop under 15-A Load: A value of 6 % or higher is not acceptable.
3. Ground Impedance: Values of up to 2 ohms are acceptable.
4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
5. Using the test plug, verify that the device and its outlet box are securely mounted.
6. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

END OF SECTION 262726

# SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

## PART 1 - GENERAL

### 1.1 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 and all other sections of Division 26.

### 1.2 SUMMARY

A. Section Includes:

1. Fusible switches.
2. Nonfusible switches.
3. Enclosures.

### 1.3 DEFINITIONS

A. NC: Normally closed.

B. NO: Normally open.

C. SPDT: Single pole, double throw.

### 1.4 SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

1. Enclosure types and details for types other than NEMA 250, Type 1.
2. Current and voltage ratings.
3. Short-circuit current ratings (interrupting and withstand, as appropriate).
4. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
5. UMB Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device

B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.

1. Wiring Diagrams: For power, signal, and control wiring.

C. Qualification Data: For qualified testing agency.

D. Field quality-control reports.

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

E. Manufacturer's field service report.

F. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.

1.5 Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Comply with NFPA 70.

## 1.6 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than minus $22^0$F and not exceeding $104^0$F.
2. Altitude: Not exceeding six thousand six hundred (6,600) feet.

B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by UMB or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify UMB no fewer than ten (10) days in advance of proposed interruption of electric service.
2. Indicate method of providing temporary electric service.
3. Do not proceed with interruption of electric service without UMB's written permission.
4. Comply with NFPA 70E.

## 1.7 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

## 1.8 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: Equal to 10 % of quantity installed for each size and type, but no fewer than three of each size and type.
2. Fuse Pullers: Two (2) for each size and type.

## 1.9 WARRANTY/GUARANTEE

A. See Division 26 Specification Section "Basic Electrical Requirements' for warranty and guarantee requirements.

## PART 2 - PRODUCTS

### 2.1 FUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Square D; a brand of Schneider Electric.

B. Type HD, Heavy Duty, Single Throw, 240 or 600 V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position. Fuses shall be rated for an interrupting capacity of 200,000 amps.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper neutral conductors.
3. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper neutral conductors.
4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
5. Auxiliary Contact Kit: **One** NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
6. Hookstick Handle: Allows use of a hookstick to operate the handle.
7. Lugs: Mechanical type, suitable for number, size, and conductor material.

### 2.2 NONFUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Square D; a brand of Schneider Electric.

B. Type HD, Heavy Duty, Single Throw, 240 or 600 V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper neutral conductors.
3. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper neutral conductors.
4. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
5. Hookstick Handle: Allows use of a hookstick to operate the handle.
6. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.3 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.

1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
2. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4X non-metallic.
3. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

B. Install individual floor-mounted switches and circuit breakers with tops at uniform height, utilizing properly secured channels anchored to floor and ceiling.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

D. Install fuses in fusible devices.

E. Comply with NECA 1.

## 3.3 IDENTIFICATION

A. Comply with requirements in Division 26 Section "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each enclosure with engraved metal or laminated-plastic nameplate.

## 3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

D. Acceptance Testing Preparation:

1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

E. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:

a. Initial Infrared Scanning: After Substantial Completion, but not more than sixty (60) days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.
b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch and circuit breaker eleven (11) months after date of Substantial Completion.

c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

F. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken and observations after remedial action.

## 3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Overcurrent Protective Device Coordination Study".

END OF SECTION 262816

# SECTION 262933 - CONTROLLERS FOR FIRE-PUMP DRIVERS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:

1. Full-service, full-voltage controllers rated 600 V and less.

### 1.3 DEFINITIONS

A. ATS: Automatic transfer switch(es).

B. ECM: Electronic control module.

C. MCCB: Molded-case circuit breaker.

D. NO: Normally open.

E. PID: Proportional integral derivative.

F. VFC: Variable-frequency controller(s)

### 1.4 ACTION SUBMITTALS

A. Product Data: For each type of product. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For each type of product indicated.

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Show tabulations of the following:

a. Each installed unit's type and details.
b. Enclosure types and details for types other than NEMA 250, Type 2.
c. Factory-installed devices.
d. Nameplate legends.
e. Short-circuit current (withstand) rating of integrated unit.
f. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices.
g. Specified modifications.

4. Include diagrams for power, signal, alarm, control wiring, and pressure-sensing tubing.

## 1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Product Certificates: For each type of product indicated, from manufacturer.

C. Source quality-control reports.

D. Field quality-control reports.

## 1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of product indicated to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.

## 1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Indicating Lights: Two of each type and color of lens installed; twoof each type and size of lamp installed.
2. Auxiliary Contacts: One for each size and type of magnetic contactor installed.
3. Power Contacts: Three for each size and type of magnetic contactor installed.
4. Contactor Coils: One for each size and type of magnetic controller installed.
5. Relay Boards: One for each size and type of relay board installed.
6. Operator Interface: One microprocessor board(s), complete with display and membrane keypad.

1.8 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of an NRTL.

B. Source Limitations: Obtain fire-pump controllers and all associated equipment from single source or producer.

1.9 FIELD CONDITIONS

A. Environmental Limitations:

1. Ambient Temperature Rating: Not less than 40 deg F (5 deg C) and not exceeding 122 deg F (50 deg C) unless otherwise indicated.
2. Altitude Rating: Not exceeding 6600 feet (2010 m) unless otherwise indicated.

B. Interruption of Existing Electric Service: Notify Owner no fewer than seven days in advance of proposed interruption of electric service, and comply with NFPA 70E.

**PART 2 - PRODUCTS**

2.1 PERFORMANCE REQUIREMENTS

A. Comply with NFPA 20 and NFPA 70.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 FULL-SERVICE CONTROLLERS

A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. Fire Pump Controllers:
   a. ASCO; a brand of Vertiv.
   b. Eaton.
   c. Hubbell Incoroporated.
   d. Master Control Systems, Inc.

B. General Requirements for Full-Service Controllers:

1. Comply with NFPA 20 and UL 218.
2. Combined automatic and nonautomatic operation.
3. Factory assembled, wired, and tested; continuous-duty rated.

C. Method of Starting:

1. Pressure-switch actuated.

a. Water-pressure-actuated switch and pressure transducer with independent high- and low-calibrated adjustments responsive to water pressure in fire-suppression piping.
b. System pressure recorder, electric ac driven, with spring backup.
c. Programmable minimum-run-time relay to prevent short cycling.
d. Programmable timer for weekly tests.

2. Magnetic Controller: Across-the-line type.
3. Emergency Start: Mechanically operated start handle that closes and retains the motor RUN contactor independent of all electric or pressure actuators.

D. Method of Stopping: Automatic and nonautomatic shutdown after automatic starting.

E. Capacity: Rated for fire-pump-driver horsepower and short-circuit-current (withstand) rating equal to or greater than short-circuit current available at controller location.

F. Method of Isolation and Overcurrent Protection: Interlocked isolating switch and nonthermal MCCB; with a common, externally mounted operating handle, and providing locked-rotor protection.

G. Door-Mounted Operator Interface and Controls:

1. Monitor, display, and control the devices, alarms, functions, and operations listed in NFPA 20 as required for drivers and controller types used.
2. Method of Control and Indication:

a. Microprocessor-based logic controller, with multiline digital readout.
b. Membrane keypad.
c. LED alarm and status indicating lights.

3. Local and Remote Alarm and Status Indications:

a. Controller power on.
b. Motor running condition.
c. Loss-of-line power.
d. Line-power phase reversal.
e. Line-power single-phase condition.

4. Audible alarm, with silence push button.
5. Nonautomatic START and STOP push buttons or switches.

H. Optional Features:

1. Extra Output Contacts:

    a. One NO contact(s) for motor running condition.
    b. One set(s) of contacts for loss-of-line power.
    c. One each, Form C contacts for high and low reservoir level.

2. Local alarm bell.
3. Door-mounted thermal or impact printer for alarm and status logs.
4. Operator Interface Communications Ports: USB, Ethernet, and RS485.

I. ATS:

1. Complies with NFPA 20, UL 218, and UL 1008.
2. Integral with controller as a listed combination fire-pump controller and power transfer switch.
3. Automatically transfers fire-pump controller from normal power supply to alternate power supply in event of power failure.
4. Allows manual transfer from one source to the other.
5. Alternate-Source Isolating and Disconnecting Means: Mechanically interlocked isolation switch and circuit breaker rated at a minimum of 115 percent of rated motor full-load current, with an externally mounted operating handle; circuit breaker shall be provided with nonthermal sensing, instantaneous-only short-circuit overcurrent protection to comply with available fault currents.
6. Local and Remote Alarm and Status Indications:

    a. Normal source available.
    b. Alternate source available.
    c. In normal position.
    d. In alternate position.
    e. Isolating means open.

7. Audible alarm, with silence push button.
8. Nonautomatic (manual, nonelectric) means of transfer.

## 2.3 ENCLOSURES

A. Fire-Pump Controllers and ATS: NEMA 250, to comply with environmental conditions at installed locations and NFPA 20.
    1. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12 (IEC IP12).

B. Enclosure Color: Manufacturer's standard "fire-pump-controller red".

C. Nameplates: Comply with NFPA 20; complete with capacity, characteristics, approvals, listings, and other pertinent data.

2.4 SOURCE QUALITY CONTROL

A. Testing: Test and inspect fire-pump controllers according to requirements in NFPA 20 and UL 218.

1. Verification of Performance: Rate controllers according to operation of functions and features specified.

B. Fire-pump controllers will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine areas and surfaces to receive equipment, with Installer present, for compliance with requirements and other conditions affecting performance.

B. Examine equipment before installation. Reject equipment that is wet or damaged by moisture or mold.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 CONTROLLER INSTALLATION

A. Coordinate installation of controllers with other construction including conduit, piping, fire-pump equipment, and adjacent surfaces. Maintain required clearances for workspace and equipment access doors and panels. Ensure that controllers are within sight of fire-pump drivers.

B. Coordinate sizes and locations of concrete bases with actual equipment provided.

C. Install controllers within sight of their respective drivers.

D. Connect controllers to their dedicated pressure-sensing lines.

E. Wall-Mounting Controllers: Install controllers on walls with disconnect operating handles not higher than 79 inches (2006 mm) above finished floor, and bottom of enclosure not less than 12 inches (305 mm) above finished floor unless otherwise indicated. Bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems."

F. Floor-Mounting Controllers: Install controllers on concrete base(s), using floor stands high enough so that the bottom of enclosure cabinet is not less than 12 inches (305 mm) above finished floor. Comply with requirements for concrete bases specified in Section 033000 "Cast-in-Place Concrete."

1. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base, and anchor into structural concrete floor.
2. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
3. Install anchor bolts to elevations required for proper attachment to supported equipment.

G. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

## 3.3 POWER WIRING INSTALLATION

A. Install power wiring between controllers and their services or sources, and between controllers and their drivers. Comply with requirements in NFPA 20, NFPA 70, and Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

## 3.4 CONTROL AND ALARM WIRING INSTALLATION

A. Install wiring between controllers and remote devices and facility's central monitoring system. Comply with requirements in NFPA 20, NFPA 70, and Section 260523 "Control-Voltage Electrical Power Cables."

B. Install wiring between controllers and the building's fire-alarm system. Comply with requirements specified in Section 284621.11 " Addressable Fire-Alarm Systems."

C. Bundle, train, and support wiring in enclosures.

D. Connect remote manual and automatic activation devices where applicable.

## 3.5 IDENTIFICATION

A. Comply with requirements in NFPA 20 for marking fire-pump controllers.

B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification in NFPA 20 and as specified in Section 260553 "Identification for Electrical Systems."

## 3.6 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

D. Acceptance Testing Preparation:

1. Inspect and Test Each Component:

    a. Inspect wiring, components, connections, and equipment installations. Test and adjust components and equipment.
    b. Test insulation resistance for each element, component, connecting supply, feeder, and control circuits.
    c. Test continuity of each circuit.

2. Verify and Test Each Electric-Drive Controller:

    a. Verify that voltages at controller locations are within plus 10 or minus 1 percent of motor nameplate rated voltages, with motors off. If outside this range for any motor, notify Owner before starting the motor(s).
    b. Test each motor for proper phase rotation.

3. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. Field Acceptance Tests:

1. Do not begin field acceptance testing until suction piping has been flushed and hydrostatically tested and the certificate for flushing and testing has been submitted to Owner and authorities having jurisdiction.
2. Prior to starting, notify authorities having jurisdiction of the time and place of the acceptance testing.
3. Engage manufacturer's factory-authorized service representative to be present during the testing.
4. Perform field acceptance tests as outlined in NFPA 20.

F. Controllers will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports.

## 3.7 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

## 3.8 ADJUSTING

A. Adjust controllers to function smoothly and as recommended by manufacturer.

B. Set field-adjustable switches, auxiliary relays, time-delay relays, and timers.

C. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.

D. Set field-adjustable pressure switches.

## 3.9 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until enclosed controllers are ready to be energized and placed into service.

B. Replace controllers whose interiors have been exposed to water or other liquids prior to Substantial Completion.

END OF SECTION 262933

# SECTION 263213 - ENGINE GENERATORS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. This Section includes a packaged natural gas driven engine-generator set for power supply with the following features:

1. Natural gas driven generator set.
2. Unit-mounted radiator cooling system.
3. Unit-mounted control and monitoring.
4. Performance requirements for sensitive loads.
5. Outdoor enclosure.
6. Walk-in sound-attenuated enclosure.
7. SCADA or BMS interface.

### 1.3 DEFINITIONS

A. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

### 1.4 REFERENCE STANDARDS

A. NEMA MG-1 – Motors and Generators

B. IEEE446 – Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications

C. NFPA 37 - Standard for Installation and Use of Stationary Combustion Engines and Gas Turbines

D. NFPA 110 – Standard for Emergency and Standby Power Systems

E. IEC8528 Part 4 – Control Systems for Generator Sets

### 1.5 SUBMITTALS

A. Product Data: For each type of packaged engine generator indicated. Include rated

capacities, operating characteristics, and furnished specialties and accessories. In addition, include the following:

1. Thermal damage curve for generator.
2. Time-current characteristic curves for generator protective device.
3. Engine performance and specs.
4. Alternator performance and specs.
5. Water jacket heater wattage, voltage and phases.
6. Silencer, wye fitting, flexible connections and connecting pipes.
7. Radiator duct flanges.
8. Output circuit breaker.
9. Control panel and monitoring system.
10. Exhaust piping, stack and components.
11. Enclosure, enclosure sound performance data, and ventilation calculations.
12. Battery, battery rack, battery charger, wiring diagrams, and components.
13. Muffler characteristics.
14. Information on engine characteristics:

    a. Make, type, and number of cylinders
    b. Brake horsepower (bhp) available
    c. Jacket water heat rejection
    d. Cooling pump characteristics
    e. Space heat gain
    f. Exhaust flow rate and temperature at 25, 50, 75 and 100% rated load
    g. Ventilation requirements
    h. Combustion air requirements
    i. Fuel consumption rates at 25, 50, 75, and 100% rated load
    j. Emission characteristics
    k. Liquid refill capacities
    l. Exhaust backpressure limitation
    m. Type and manufacturer of governor
    n. Alternator size to limit voltage dip to 10%

15. Information on generator characteristics:

    a. Make and type
    b. Type of construction and overspeed capabilities
    c. Temperature rise
    d. Regulation characteristics
    e. Space heat gain
    f. Ventilation requirements
    g. Type of winding insulation
    h. KW, KVA, power factor
    i. Type of exciter and voltage regulator
    j. Voltage, phase, wire
    k. RPM

l. Winding pitch

B. 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.

1. Dimensioned outline plan and elevation drawings of enclosure, generator set, exhaust piping, and other components specified.

a. Outline drawings of equipment showing weights
b. Overall dimensions including bolting template and earthquake restraints
c. Right hand, left hand, end, and top views of proposed assembly
d. Stub ups/entrance location for fuel
e. Power and control wiring entrance locations
f. Lug sizes and locations
g. Overall dimensioned drawings of stairs and landings.
h. Weather protective enclosure installation drawings, structural calculations, lighting fixture catalog cut, panels, motor starters, transformer, conduit, and wiring.

2. Design Calculations: Signed and sealed by a qualified professional engineer. Calculate requirements for selecting exhaust piping, supports, vibration isolators and seismic restraints and for designing vibration isolation bases.
3. Vibration Isolation Base Details: Signed and sealed by a qualified professional engineer. Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include base weights.
4. Wiring Diagrams: Power, signal, and control wiring.
5. Enclosure design temperature rise and ventilation calculations.
6. Exhaust piping and stack layout and sizing: Submit detailed engineering calculations and coordinated drawings of the exhaust piping system to include wye fitting, flexible connections, expansion joints, exhaust piping, stack, fittings and the silencer. Demonstrate that the exhaust piping is properly sized for the maximum allowable exhaust backpressure of the engine provided including a 15% safety/ service factor. Provide the calculation. Shop drawings shall indicate actual conditions, drawn to scale with dimensions.

C. Manufacturer Sizing Calculations: The manufacturer shall submit a generator sizing calculation to verify the generator will start and maintain the connected loads based on step loads of 25%, 50%, and 65%.

D. Manufacturer Seismic Qualification Certification: Submit certification that the engine-generator set, batteries, battery rack, accessories and components will withstand seismic forces. Include the following:

1. Basis of Certification: Indicate whether withstand certification is based on actual

test of assembled components or on calculation.

a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Interconnection detail drawing showing control and power connections of the complete system. Clearly differentiate between factory installed, vendor field installed, and contractor field installed wiring. Control connections between components are to be labeled with identical nomenclature. Coordinate with existing switchgear manufacturer.

F. Installation instructions for generators and exhaust piping components.

1. Accessories including fuel lines, flexible exhaust couplings, exhaust flange, and other exhaust system components.

G. Complete review of this specification, noting for each paragraph whether or not proposed equipment complies with project specifications, or deviates in some fashion. Justification must be provided for each deviation.

H. Complete test specification detailing testing procedure to be used to verify performance of equipment provided.

I. Test Reports:

1. Report of factory test on units to be shipped for this Project, showing evidence of compliance with the specified requirements.
2. Report of exhaust emissions showing compliance with applicable regulations and this specification section.
3. Report of sound generation.
4. Submit certified factory tests report on engine-generator delivery. Alarms, sensors, and meters must be tested and certified.
5. Submit, upon completion of installation and testing of engine-generator sets, certified test reports from load tests for engine-generator.

J. Field quality-control test reports.

K. Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.

L. Recommended spare parts list (with pricing) for beyond initial 2 years of operation.

M. Warranty: Special warranty specified in this Section.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

1. Maintenance Proximity: Not more than 2 hours' normal travel time from Installer's place of business to Project site and shall be available on a 24-hour basis.

B. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 50 miles of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.

C. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL), and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

D. Source Limitations: Obtain packaged generator sets and auxiliary components through one source from a single manufacturer.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

F. Comply with ASME B15.1.

G. Comply with NFPA 37.

H. Comply with NFPA 70.

I. Comply with NFPA 99.

J. NEMA MG-1 – Motors and Generators

K. IEEE446 – Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications

L. Engine Exhaust Emissions: Comply with applicable state and local government requirements and requirements specified in this section.

M. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at adjacent property boundaries due to sound emitted by generator set including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation. Generator shall rest inside a noise attenuating enclosure provided by the manufacturer. Sound attenuating items include, but are not limited to, sound louvers, dampers, sound attenuated walls, intake baffles, and discharge baffles. Intakes shall prevent water penetration.

1.7 PROJECT CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify UMB no fewer than 14 days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without UMB's written permission.

B. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions outside the enclosure without mechanical or electrical damage or degradation of performance capability:

1. Ambient Temperature: $5^0$C to $40^0$C.
2. Altitude: Sea level to 1000 feet.

1.8 COORDINATION

A. Coordinate size and location of concrete bases for package engine generators. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Provide services of a professional rigging company, where necessary, to provide proper handling and positioning of unit.

C. Provide all labor and material, storage, etc. for receiving the equipment, storage, transportation to the project site and installation into final location.

1.9 WARRANTY

1. Warranty: Full parts and labor warranty to repair or replace any defective component due to manufacture or installation defect.
2. Warranty Period: 5 years from date of Substantial Completion.

1.10 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, provide 24 months' full maintenance by skilled employees of manufacturer's designated service organization. Include quarterly exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Provide all parts and supplies same as those used in the manufacture and installation of original equipment.

1.11 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: One for every 10 of each type and rating, but no fewer than one of each.
2. Indicator Lamps: Two for every six of each type used, but no fewer than two of each.
3. Filters: Two sets each of lubricating oil, fuel, and combustion-air filters.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Subject to compliance with requirements, provide a natural gas driven engine-generator with a sound attenuated weather enclosure, subject to compliance with the requirements, as manufactured by:

1. Onan/Cummins Power Generation; Industrial Business Group.
2. MTU Onsite Energy
3. Caterpillar; Engine Div.
4. Kohler Co.; Generator Division.

2.2 ENGINE-GENERATOR SET

A. Factory-assembled and -tested, engine-generator set.

1. kW/kVA @ 0.8 pf: 2000kW/2500kVA
2. Rating: Continuous Duty

3. Voltage: 13.2/7.6kV
4. Phase: 3
5. Wire: 4

B. Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation; and have lifting attachments.

1. Rigging Diagram: Inscribed on metal plate permanently attached to mounting frame to indicate location and lifting capacity of each lifting attachment and generator-set center of gravity.

C. Capacities and Characteristics:

1. Fuel: Natural Gas
2. Power Output Ratings: kW/kVA @ 0.8 pf: 2000kW/2500kVA
3. Voltage: 13.2/7.6kV
4. Phase: 3
5. Wire: 4
6. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.
7. Heavy duty, single bearing, pre-lubricated type.
8. Alternator Insulation System Temperature Rise: $105^0$C.
9. Self ventilating via direct drive blower.
10. Maximum speed not greater than 1800 rpm.
11. Flexible coupling of generator shaft to engine flywheel.
12. Self-regulating: Revolving field, 4-pole, brushless AC exciter with rotating rectifiers or static-exciter regulator assembly.
13. Stator twice impregnated with varnish, skewed to minimize heating and harmonics.
14. Excitor shall be full-wave rectifier with silicon diodes mounted on rotor shaft. Manual reset circuit breaker shall protect field circuit.
15. Class "H" for $150^0$C rise over a $40^0$C ambient, as defined by NEMA Standard MG1-1.65.
16. 2/3 Pitch. Sub transient Reactance: Maximum of 12%.

D. Generator-Set Performance for Non-Sensitive Loads:

1. Accept 65% block load.
2. Steady-State Voltage Operational Bandwidth: 3 percent of rated output voltage from no load to full load.
3. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within three seconds.
4. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.
5. Steady-State Frequency Stability: When system is operating at any constant load

within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.

6. Transient Frequency Performance: Less than 5 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within five seconds.
7. Output Waveform: At no load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for single harmonics. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
8. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 250 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.

E. Factory Prototype Test Certified

1. Harmonic Distortion Levels

   a. Demonstrate

2. Airflow Restriction tests

   a. Demonstrate controlled shutdown after overheating

3. Unit tested with enclosure
4. 30 Degree Water Spray Unit Rain Test

   a. Demonstrate no water leakage into electrical boxes

5. Overload Test

   a. Demonstrate 10% overload with no damage to engine

6. Air Filter Test

   a. Demonstrate engine contains engine backfire explosion

F. Factory Production Test Certified

1. Alternator Impedance to Ground
2. Dielectric Testing
3. Maximum kW Rating
4. Engine Response Time
5. Alternator Construction Testing

   a. Impedance Balance Tested

6. Alternator Insulation Testing

a. Surge Tested

2.3 ENGINE

A. Fuel: Natural Gas.

B. Rated Engine Speed: 1800 rpm.

C. Maximum Piston Speed for Four-Cycle Engines (2-Cycle engines are not permitted): 2250 fpm.

D. Nox Emissions: 0.5 g/bhp/hr

E. Lubrication System: The following items are mounted on engine or skid:

1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.
4. The lubrication system shall be of the full pressure type.
5. Replaceable full flow oil filters.

F. Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system.

1. Thermostatically controlled isolation valves for servicing. Provide disconnect switch at generator.

G. Governor: Adjustable isochronous, with speed sensing.

1. Cummins EFC, Woodward 2301, or equal.
2. Frequency variation shall not exceed +/- 0.25% for constant loads from 0-100%.

H. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine-generator-set mounting frame and integral engine-driven coolant pump.

1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer. Fill engine cooling system with solution of 50/50 mix ethylene glycol at initial fill.
2. Size of Radiator: Adequate to contain thermal expansion of total system coolant from cold start to 110 percent load condition.

a. Radiator Cooling (CFM)
b. Generator Cooling (CFM)

3. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
4. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, ultraviolet-, and abrasion-resistant fabric.

a. Rating: 1.5 times the maximum operating pressure and temperature but not less than 50-psig working pressure with coolant at 180 deg F, and noncollapsible under vacuum.
b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

I. Muffler/Silencer: Critical Grade type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.

1. Muffler/Silencer:

a. Performance: Sound level measured at a distance of 60 feet from exhaust discharge after installation is complete shall be 61dBA at 300-3000 Hz or less.
b. Construction: Heavy duty carbon steel with ANSI connections sized for application. Inlet to silencer shall be on the bottom, side discharge.
c. Connections: ANSI Flanged.
d. Finish: High heat black or silver paint.
e. Pressure drop range: 6” to 11” WC. Note that silencer shall be selected based on consideration of the overall exhaust piping system pressure drop including safety/service factors and the maximum allowable engine backpressure.

2. Size silencer, wye fitting and piping to ensure that the measured exhaust back pressure does not exceed maximum limitations recommended by unit manufacturer including safety factor.
3. Catalytic Converter: Generator manufacturer shall provide a catalytic converter (as necessary) to comply with Federal Air Emissions Standards 40 CFR Part 60 JJJJ.
4. Condensate Drain for Muffler: Schedule 40, black steel pipe connected to silencer drain outlet through a petcock.
5. Exhaust Piping Connection: Provide piping, wye fittings and flexible joints for connection to engine complete with necessary fittings, flanges, gaskets, bolts, and nuts.

J. Engine Wye Fittings

1. Description: Provide wye fitting (if required) in generator enclosure when engine has two exhaust outlets. Wye fitting shall combine exhaust from dual outlet engines for more efficient outflow distribution.
2. Construction: All welded, carbon steel with 321 stainless steel corrugated flex hose.
3. Connections: Provide ANSI flanges. ANSI flanges may be replaced with engine flanges.
4. Pressure drop range: 6" to 11" WC. Note that the wye fitting shall be selected based on the engine and silencer configuration and in consideration of the overall exhaust piping system pressure drop including safety/service factors and the maximum allowable engine backpressure.
5. Size silencer, wye fitting and piping to ensure that the measured exhaust back pressure does not exceed maximum limitations recommended by unit manufacturer including safety factor.

K. Air-Intake Filter: Heavy-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.

L. Starting System: 24-V electric, with negative ground.

1. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in Part 1 "Project Conditions" Article.
2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
3. Cranking Cycle: As required by NFPA 110 for system level specified.
4. Battery: Adequate capacity within ambient temperature range specified in Part 1 "Project Conditions" Article to provide specified cranking cycle at least three times without recharging.

    a. Lead calcium type batteries.
    b. CCA rated per engine manufacturer for 0 degrees F starting.
    c. Non-metallic, corrosion resistant rack.
    d. Champion, Interstate, Exide, C&D Charter, or equal.

5. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
6. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater shall be arranged to maintain battery above 10 deg C regardless of external ambient temperature within range specified in Part 1 "Project Conditions" Article. Include accessories required to support and fasten batteries in place.
7. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.

8. Battery Charger: Current-limiting, automatic-equalizing and float-charging type. Unit shall comply with UL 1236 and include the following features:

   a. Operation: Equalizing-charging rate of 20 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
   b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 deg C to plus 60 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.
   c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
   d. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.
   e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
   f. Enclosure and Mounting: NEMA 250, Type 1, wall-mounted cabinet.

## 2.4 CONTROL AND MONITORING

A. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of generator set. When mode-selector switch is switched to the on position, generator set starts. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down generator set.

B. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common control and monitoring panel mounted on the generator set. Mounting method shall isolate the control panel from generator-set vibration.

C. Indicating and Protective Devices and Controls:

   1. AC voltmeter.
   2. AC ammeter.
   3. AC frequency meter.
   4. DC voltmeter (alternator battery charging).
   5. Engine-coolant temperature gage.

6. Engine lubricating-oil pressure gage.
7. Running-time meter.
8. Ammeter-voltmeter, phase-selector switch(es).
9. Generator-voltage adjusting rheostat.
10. Low gas pressure alarm.
11. Generator overload.
12. Failed to synchronize.

D. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated.

E. Connection to Data Link: A separate terminal block, factory wired to Form C dry contacts, for each alarm and status indication is reserved for connections for data-link transmission of indications to remote generator control switchgear. Coordinate connection requirements with the generator control switchgear integrator.

F. Common Remote Audible/Visual Alarm: Include necessary contacts and terminals in control and monitoring panel.

1. Overcrank shutdown.
2. Low oil pressure.
3. High engine temperature.
4. Overspeed.
5. System ready.
6. Low battery voltage.
7. High engine temperature (pre-alarm).
8. Low oil pressure (pre-alarm)
9. Coolant low-temperature alarm.
10. Control switch not in auto position.
11. Battery-charger malfunction alarm.
12. Battery low-voltage alarm.
13. Auxiliary alarm.
14. Auxiliary (pre-alarm).
15. Ground fault indication.
16. Engine running.

G. Automatic Shutdown Control:

1. Emergency stop.
2. Fail to crank.
3. High AC voltage.
4. High coolant temperature.
5. Low AC voltage.
6. Low oil pressure.
7. Over-crank.

8. Over-speed.
9. Short circuit.
10. Under-frequency.
11. Low coolant level.

H. Remote Alarm Annunciator: Comply with NFPA 99. An LED labeled with proper alarm conditions shall identify each alarm event and a common audible signal shall sound for each alarm condition. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface- or flush-mounting type to suit mounting conditions indicated.

1. Overcrank shutdown.
2. Low oil pressure.
3. High engine temperature.
4. Over-speed.
5. System ready.
6. Low battery voltage.
7. High engine temperature (pre-alarm).
8. Low oil pressure (pre-alarm)
9. Coolant low-temperature alarm.
10. Control switch not in auto position.
11. Battery-charger malfunction alarm.
12. Battery low-voltage alarm.
13. Auxiliary alarm.
14. Auxiliary (pre-alarm).
15. Ground fault indication
16. Engine running.

I. Remote Emergency-Stop Switch: Flush; wall mounted, unless otherwise indicated; and labeled. Push button shall be protected from accidental operation.

2.5 GENERATOR OVERCURRENT AND FAULT PROTECTION

A. Generator Circuit Breaker: Insulated-case, electronic-trip type; 100 percent rated; complying with UL 489.

1. Tripping Characteristics: Adjustable long-time and short-time delay and instantaneous.
2. Trip Settings: Selected to coordinate with generator thermal damage curve.
3. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.
4. Mounting: Adjacent to or integrated with control and monitoring panel.

B. Ground-Fault Indication: Comply with NFPA 70, "Emergency System" signals for ground-fault. Integrate ground-fault alarm indication with other generator-set alarm

indications.

2.6 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

A. Comply with NEMA MG 1.

B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.

C. Electrical Insulation: Class H minimum.

D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.

E. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.

F. Enclosure: Dripproof.

G. Instrument Transformers: Mounted within generator enclosure.

H. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified.

1. Adjusting rheostat on control and monitoring panel shall provide plus or minus 5 percent adjustment of output-voltage operating band.

I. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.

J. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.

K. Subtransient Reactance: 12 percent, maximum.

L. Manual digital adjustment.

M. Synchronous operation for immunity to SCR tracking.

N. Steady state output voltage maintained at +/- 0.5% of rated voltage from 0-100%

O. Output voltage recovery to +/- 1% of final voltage in less than 4 seconds after adding/removal 25% load increments.

2.7 NEUTRAL GROUNDING RESISTOR

A. Resistor

1. 8,000 kV, 400 Amp, 10 second rated.
2. The neutral grounding resistor (NGR) shall utilize edge wound stainless steel load resistors of sufficient mass to withstand the rated current and prescribed duty.
3. The entire resistor assembly shall be mounted on insulators rated for the system voltage.
4. All resistor terminals and interconnections between the resistor units shall be stainless steel using stainless steel hardware.
5. Connections between resistors and bushing or current transformers shall be solid copper or stainless steel bus, or copper cables.

B. Enclosure

1. The NGR shall be supplied with a NEMA 3R louvered, hot dip galvanized enclosure with stainless steel hardware suitable for outdoor installation.

C. Accessories

1. The NGR shall be provided with a bar type ground fault current transformer (CT). The CT shall be connected to the NGR and have terminals for field wiring connections. A NEMA 4X junction box shall be provided with shorting terminal blocks for the CT connections.

2.8 NATURAL GAS SERVICE METER ASSEMBLY

A. Turbine Meters: Comply with ASME MFC-4M

1. Manufacturers: Subject to compliance with requirements, provide UL Listed products by Sensus or equal.
2. Housing: Cast iron or welded steel.
3. Connection Threads or Flanges: Steel.
4. Turbine: Aluminum or plastic.
5. Turbine Bearings: Self-lubricating, ABEC L10 bearing life.
6. Compensation: Continuous temperature.
7. Meter Index: Cubic feet.
8. Tamper resistant.
9. Remote meter reader compatible.
10. Maximum Inlet Pressure: 100 psig.
11. Accuracy: Maximum plus or minus 2.0 percent.

B. Gas Volume Corrector.

1. Manufacturers: Subject to compliance with requirements, provide products by Roots Meters & Instruments; Dresser, Inc. or equal
2. Instrument Drive Mounted.
3. Automatic bi-directional index drive.
4. 4-20mA output connector configured to provide a 4-20mA output to the

switchgear ION7650 meters.
5. Accuracy: -40$^0$F to 140$^0$F.
6. Corrected Volume: +/-0.5%

## 2.9 SOUND ATTENUATED ENCLOSURE

A. The generator set shall be housed in a ruggedly constructed, weatherproof aluminum enclosure enclosing control panel, battery charger, circuit breaker and all other generator-mounted devices. The enclosure shall have inspection doors located at all control and maintenance points for easy access. Doors shall be complete with continuous piano hinge gasketing and key locking handles. Expanded metal louvers or hoods shall be located for cooling air inlet. Roof shall be one-piece construction with provisions for exhaust pipe penetration and support of silence and exhaust pipe. A minimum of two lifting eyes shall be provided for hoisting of enclosure only. A steel perimeter frame shall be provided for mounting onto the generator set skid rails. All penetrations for conduit, piping, exhaust, etc. shall be sealed to maintain weatherproof and sound attenuating properties. Sound attenuation shall reduce noise levels to 61 dBA at a distance of 60 feet in all directions after installation is complete.

B. Description: Vandal-resistant, weatherproof steel housing, wind resistant up to 115 mph. Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Panels shall be removable by one person without tools. Instruments and control shall be mounted within enclosure. Sound attenuation shall be 61 dBA at a distance of 60 feet after installation is complete.

C. Description: Prefabricated enclosure with the following features:

1. Maximum allowable overall dimensions for the enclosure is 44’-0” long by 14’-0” wide. There is no restriction on height.
2. Construction: Galvanized-steel, metal-clad, integral structural-steel-framed enclosure erected on concrete foundation.
3. Structural Design and Anchorage: Comply with ASCE 7 for wind loads.
4. Space Heater: Thermostatically controlled and sized to prevent condensation and to maintain batteries at an acceptable temperature (cold cranking).
5. Louvers: Equipped with bird screen and filter arranged to prevent exterior dust, birds, and rodents.
6. Hinged Doors: With padlocking provisions.
7. Ventilation: Louvers equipped with bird screen and filter arranged to permit air circulation while excluding exterior dust, birds, and rodents. Provide two position dampers. Louvers sized to prevent rain, snow, and water intrusion at full engine load and radiator airflow.
8. Thermal Insulation: Manufacturer's standard materials and thickness selected in coordination with space heater to maintain winter interior temperature within operating limits required by engine-generator-set components and noise criteria.
9. Silencer Location: External to enclosure on roof, provide integral steel support.
10. Provide natural gas detection system with automatic gas supply shutoff to engine.

11. Provide manufacturer's standard paint finish.
12. Provide small exhaust fan, sized by generator manufacturer for a 10 Deg. F temperature rise at 94 Deg. F dry bulb design conditions, for when engine is not in operation.

D. Engine Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for 2 hours with ambient temperature outside the enclosure at top of range specified in system service conditions but not less than 40 Deg. C.

1. Louvers: Fixed-engine, cooling-air inlet and discharge. Storm-proof and drainable louvers prevent entry of rain and snow.
2. Automatic Dampers: At engine cooling-air inlet and discharge. Electric two position – open/close. Dampers shall be closed to reduce enclosure heat loss in cold weather when unit is not operating.

E. Exterior Deck: The enclosure fabricator shall include any necessary exterior stairs to access all of access doors to the generator enclosure. Proposed configurations shall be provided to the Owner for approval prior to fabrication. Where two generators are side by side, subject to approval by the Owner a common platform and stair arrangement between the generators will be considered. Stairs and deck shall be constructed using galvanized steel or aluminum and be equipped with flanges and bolts to secure the platform to the enclosure and to the pad/ground below. Stairs and platform shall meet the following requirements.

1. Provide structure capable of handling a minimum deck loading of 500 lbs.
2. Stair treads and decking material shall be constructed utilizing a serrated welded steel bar grating material. Width of stairs and deck shall be 42".
3. Touchup any scratches to the steel finish with galvanizing repair paint. High-zinc-dust content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

F. Interior Lights with Switch: Factory-wired, vaporproof-type fixtures within housing; arranged to illuminate controls and accessible interior. Arrange for external electrical connection.

1. AC lighting system and connection point for operation when remote source is available.
2. DC lighting system for operation when remote source and generator are both unavailable.

G. Exterior Lights with Photocell: Factory-wired to package power panel, weatherproof-type fixture with cage, controlled via a photocell. Arrange to provide adequate lighting at enclosure door, stairs, and landings. Minimum of two fixtures per enclosure long side, one on each end.

H. Convenience Outlets: Factory wired, GFCI. Arrange for external electrical connection.

2.10 CONCRETE EQUIPMENT PADS

A. Utilize existing concrete equipment pad for generator. Provide any additional required concrete equipment pad modifications for generator installation.

B. Anchor each generator by bolting steel unit rails to vibration isolators. Secure vibration isolators to concrete pad.

2.11 VIBRATION ISOLATION DEVICES

A. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic restraint.

1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to 1/4-inch- thick, elastomeric isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
2. Outside Spring Diameter: Not less than 80 percent of compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.12 FINISHES

A. Outdoor Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer.

2.13 SOURCE QUALITY CONTROL

A. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.

B. Project-Specific Equipment Tests: Before shipment, factory test engine-generator set and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:

1. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.
2. Full load run.
3. Maximum power.
4. Voltage regulation.

5. Transient and steady-state governing.
6. Single-step load pickup.
7. Safety shutdown.
8. Provide 14 days' advance notice of tests and opportunity for observation of tests by Owner's representative.
9. Report factory test results within 10 days of completion of test.

C. Owner will witness all required factory tests. Contractor to provide accommodations if more than 50 mi from site. Notify Owner at least 14 days before date of tests and indicate their approximate duration.

1. Attendance or non-attendance by the Owner and/or their duly authorized representatives at factory tests shall not relieve the manufacturer of responsibility to correct any defects or items of non-conformance with these specifications discovered during site testing.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine-generator performance.

B. Examine roughing-in of piping systems and electrical connections. Verify actual locations of connections before packaged engine-generator installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

A. Comply with packaged engine-generator manufacturers' written installation and alignment instructions.

B. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.

C. Install packaged engine generator with restrained spring isolators having a minimum deflection of 1 inch on 4-inch- high concrete base. Secure sets to anchor bolts installed in concrete bases.

D. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

3.3 CONNECTIONS

A. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow service and maintenance.

B. Connect engine exhaust pipe to engine with flexible connector.

C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 SERVICE-METER ASSEMBLY INSTALLATION

A. Install service-meter assemblies aboveground within generator enclosure.

B. Install metal shutoff valves upstream from service regulators. Shutoff valves are not required at second regulators if two regulators are installed in series.

C. Install strainer on inlet of service-pressure regulator and meter set.

D. Install service regulators mounted outside with vent outlet horizontal or facing down. Install screen in vent outlet if not integral with service regulator.

E. Install metal shutoff valves upstream from service meters. Install dielectric fittings downstream from service meters.

F. Install service meters downstream from pressure regulators.

3.5 IDENTIFICATION

A. Identify system components according to Division 26 Section "Identification for Electrical Systems."

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. Perform tests recommended by manufacturer and each electrical test and visual and mechanical inspection for "AC Generators and for Emergency Systems"

specified in NETA Acceptance Testing Specification. Certify compliance with test parameters.

2. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.

    a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
    b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
    c. Verify acceptance of charge for each element of the battery after discharge.
    d. Verify that measurements are within manufacturer's specifications.

3. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
4. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine-generator system before and during system operation. Check for air, exhaust, and fluid leaks.
5. Exhaust-System Back-Pressure Test: Use a manometer with a scale exceeding 40-inch wg. Connect to exhaust line close to engine exhaust manifold. Verify that back pressure at full-rated load is within manufacturer's written allowable limits for the engine.
6. Exhaust Emissions Test: Upon completion and successful commissioning of the generator installation, coordinate with the Maryland Department of the Environment (MDE) and perform Air Emissions Testing on the generator to confirm compliance with Federal Air Emissions Standards 40 CFR Part 60 JJJ. Comply with all MDE test criteria.

    a. Provide permanent test ports in the exhaust system as necessary to accommodate this testing. After testing, the test ports shall remain for UMB's future use during their required periodic testing.

7. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for manufacturer's recommended step-load increases and decreases, and verify that performance is as specified.
8. Harmonic-Content Tests: Measure harmonic content of output voltage under 25 percent and at 100 percent of rated linear load. Verify that harmonic content is within specified limits.
9. Noise Level Tests: Measure A-weighted level of noise emanating from generator-set installation, including engine exhaust and cooling-air intake and discharge, at four locations identified by the Owner, and compare measured levels with required values.

C. Coordinate tests with tests for transfer switches and paralleling switchgear and run them concurrently.

D. Test instruments shall have been calibrated within the last 12 months, traceable to standards of NIST, and adequate for making positive observation of test results. Make calibration records available for examination on request.

E. Leak Test: After installation, charge system and test for leaks of coolant and fuel systems. Repair leaks and retest until no leaks exist.

F. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

G. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

H. Remove and replace malfunctioning units and retest as specified above.

I. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.

J. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

K. In addition, the following tests shall be provided in the field.

1. Four (4) hour full load test for each generator utilizing the UMB campus (peak shaving mode) for load. Record generator operating conditions at ten (10) minute intervals.
2. Load share test. Utilizing the UMB campus for loads (peak shaving mode) demonstrate load share capabilities of the generators from 10 to 100% load in 10% increments. Record generator operating conditions and performance at each increment level.
3. Test all alarm points, safety devices and engine shutdown.
4. The contractor shall provide an alternate proposal to UMB for consideration to perform the above load tests using load banks with both resistive and reactive load capabilities. The proposal shall be a complete offer inclusive of the load bank, step up transformer (if required), cabling, labor, etc. The alternate shall be based on two capacities. 2MW capable of performing test K.1 above fully and K.2 above, each generator to 50%. 6MW capable of performing the above tests.

L. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each power wiring termination and each bus connection. Remove all success panels so terminations and connections are acceptable to portable scanner.

1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan 11 months after date of Substantial Completion.

2. Instrument: Use an infrared scanning device designated to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
3. Record of Infrared Scanning: Prepare a certified report that identifies terminations and connections checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

## 3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 263213

# SECTION 263533 - POWER FACTOR CORRECTION EQUIPMENT

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. This Section includes automatic power factor correction equipment rated 13,800 volts.

### 1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include dimensions, operating characteristics of multiple capacitor cells or elements, and data on features, ratings, and performance.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, method of field assembly, components, and location and size of each field connection. Show access and workspace requirements and required clearances.

1. Wiring Diagrams: Power, signal, and control wiring.

C. Qualification Data: Testing agency.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For equipment to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Lists of spare parts and replacement components recommended for storage at Project site.
2. Detailed instructions covering operation under both normal and abnormal conditions.

### 1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined in OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with IEEE 18 and NEMA CP 1.

D. Comply with NFPA 70.

1.5 COORDINATION

A. Coordinate sensor-communication module package with data network and with monitoring equipment specified in Division 26 Section "Electrical Power Monitoring and Control" for successful transmission and remote readout of remote monitoring data specified in this Section.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace capacitor-bank components that fail in materials or workmanship within specified warranty period.
1. Special Warranty Period for Capacitor Cells: Five years from date of Substantial Completion.

1.7 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Deliver extra materials to Owner.

1. Fuses: 1 for every 5 of each type and rating, but not less than 3 of each.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the

following:

1. Automatic Power Factor Correction Units:
   a. Eaton
   b. ABB Control, Inc.
   c. General Electric Company; Business Information Center.
   d. Square D; Division of Schneider Electric.

2.2 CAPACITORS, GENERAL

A. Construction: Multiple capacitor cells or elements, factory wired in three-phase groups and mounted in metal enclosures.

B. Capacitor Cells: Low loss, double-bushing capacitors in accordance with IEEE Std. 18.

C. Cell Rupture Protection: Pressure-sensitive circuit interrupter for each cell.

D. Capacitor-Bank Fuses: Current-limiting, noninterchangeable type; factory installed in each phase and located within the equipment enclosure. Features include the following:

1. Interrupting Capacity: 50,000 A, minimum.
2. Fuse Ratings and Characteristics: As recommended by capacitor manufacturer.
3. Neon Indicator Lamp for Each Fuse: Connect to illuminate when fuse has opened, but is still in place, and locate so it is visible from outside the enclosure.

E. Discharge Resistors: Each capacitor shall contain an internal discharge resistor to reduce the stored voltage to 50 volts or less within 5 minutes from disconnection.

F. Enclosure: NEMA 250, steel or aluminum, arranged to contain the fluid leakage from capacitor cells; factory equipped with mounting brackets suitable for type of mounting indicated.

1. Indoor Enclosures: NEMA 250, Type 12 or as indicated.

2.3 AUTOMATIC POWER FACTOR CORRECTION UNITS

A. Comply with all applicable NEMA and ANSI/IEEE standards.

B. Description: Capacitor banks, contactors, controls, and accessories factory installed in independent enclosures. Units include a separately mounted current transformer to sense current in the power circuit being corrected and to provide input to unit controls.

C. Performance Requirements: Controls permit selection of a target power factor, adjustable to any value between unity and 0.80 lagging. Controls continuously sense the power factor

on circuits being corrected and, when the power factor differs from the target setting for more than 10 seconds, operate a contractor to switch a capacitor bank into or out of the circuit. Contactors are opened or closed as required to bring the corrected circuit power factor closer to the target setting. Switch only one capacitor bank at a time.

D. Controls: Solid-state, microprocessor-based controls, including the following:

1. Undervoltage relay that interrupts capacitor switching and disconnects capacitors for power supply interruptions longer than 15 minutes.
2. "Advance" and "Retard" push buttons on the control panel to permit manually controlled capacitor-bank switching.

E. Contactors: Singe pole vacuum switches shall be used for staged capacitor switching.

F. Buses: Plated copper.

G. Fuses for Protection of Capacitor Banks: Rated to protect contactor, interconnecting wiring, and capacitors.

H. Inductors: Air-core-type, connected in capacitor circuits; rated to limit switching surges to within contactor ratings.

I. Precharge Capacitor Circuit: Resistive, precharge circuit to charge capacitors prior to switching and to limit switching surges to within contactor ratings.

J. Mechanical Bracing for Current-Carrying Parts: Adequate to withstand the maximum fault current to which they may be exposed.

K. Identification of Energized Capacitor Banks: LED indicating lamps on front panel.

L. Enclosure: NEMA 250, Type 12, steel or aluminum, with hinged door and hand-operated catch. Door shall be interlocked with controls or main circuit breaker to de-energize capacitors when door is opened.

M. Local Display: LED or liquid-crystal digital type, mounted in door of enclosure, indicating the following:

1. Target and actual power factors accurate to plus or minus 1 percent of reading.
2. Steps energized.
3. Step reconnection delay.
4. Real and reactive currents.
5. Voltage THD.
6. Alarm codes.

N. System Alarms: Alarm relay and local display indication of the following conditions:

1. Low power factor.
2. Leading power factor.
3. Frequency not detected.
4. Overcurrent.
5. Overvoltage.
6. Overtemperature.
7. Excessive voltage THD.
8. Capacitor overload.
9. Loss of capacitance.

O. Current Transformer: Type, configuration, and ratio to suit sensing and mounting conditions.

P. Load Interrupter Air Disconnect Switch: Integral disconnect switch, externally operated, mechanically chain driven with visible blades. Disconnect switch is mechanically interlocked with the ground switch. A barriers shall be provided to isolate live components.

1. Operating handle can be padlocked.

Q. Remote Monitoring Components: Sensors, associated communication modules, and network interface units, matched to and compatible with electrical power monitoring and control network. Communication module shall have capability to transmit the following data to remote monitoring devices:

1. System in alarm.
2. Power factor set-point.
3. Corrected power factor.
4. Number of capacitor steps activated.

2.4 FACTORY FINISH

A. Manufacturer's standard enamel over corrosion-resistant treatment or primer coat.

2.5 SOURCE QUALITY CONTROL

A. Factory test power factor correction equipment before shipment. Comply with NEMA CP 1. Include the following:

1. Routine capacitor production tests, including short-time overvoltage, capacitance, leak, and dissipation-factor tests.
2. Functional test of all operations, controls, indicators, sensors, and protective devices.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install freestanding equipment on concrete bases. Cast-in-place concrete is specified in Division 03.

B. Maintain minimum workspace according to manufacturer's written instructions.

C. Connect remote monitoring communication module to electrical power monitoring and control data network through appropriate network interface unit.

D. Identify components according to Division 26 Section "Identification for Electrical Systems."

### 3.2 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Test insulation resistance for each power factor correction capacitor element, bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following:

1. Inspect capacitors, wiring, components, connections, and equipment installation. Test and adjust components, and equipment.
2. Assist in field testing of equipment[ including pretesting and adjusting of automatic power factor correction units].
3. Report results in writing.

C. Testing Agency: Engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

D. Perform the following field tests and inspections and prepare test reports:

1. Perform each electrical test and visual and mechanical inspection, except optional tests, stated in NETA ATS, "Capacitors and Reactors - Capacitors." Certify compliance with test parameters.

E. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.3 ADJUSTING

A. Adjust for optimum automatic power factor correction.

3.4 CLEANING

A. After completing equipment installation, inspect unit components. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

B. Clean components internally, on completion of installation, according to manufacturer's written instructions.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain automatic power factor correction units. Demonstrate method of determining optimum settings for system controls. Refer to Division 01 Section "Demonstration and Training."

B. Conduct a minimum of two hours' training as specified in Division 01 Section "Demonstration and Training."

END OF SECTION 263533

# SECTION 263600 - TRANSFER SWITCHES

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 26.

### 1.2 SUMMARY

A. This Section includes transfer switches rated 600 V and less, including the following:

1. Automatic transfer switches.
2. Bypass/isolation switches.

### 1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, weights, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Dimensioned plans, elevations, sections, and details showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.

1. Single-Line Diagram: Show connections between transfer switch, bypass/isolation switch, power sources, and load; and show interlocking provisions for each combined transfer switch and bypass/isolation switch.

C. Qualification Data: For manufacturer and testing agency.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Features and operating sequences, both automatic and manual.
2. List of all factory settings of relays; provide relay-setting and calibration instructions, including software.

## 1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Maintain a service center capable of providing training, parts, and emergency maintenance repairs within a response period of less than eight hours from time of notification.

B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

C. Source Limitations: Obtain automatic transfer switches, bypass/isolation switches through one source from a single manufacturer.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Comply with NEMA ICS 1.

F. Comply with NFPA 70.

G. Comply with NFPA 110.

H. Comply with UL 1008 unless requirements of these Specifications are stricter.

## 1.5 PROJECT CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service, if needed.

1. Notify UMB no fewer than ten (10) days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without UMB’s written permission.

1.6 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.7 WARRANTY/GUARANTEE

A. See Division 26 Specification Section "Basic Electrical Requirements' for warranty and guarantee requirements.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. Contactor Transfer Switches:
   a. Emerson; ASCO Power Technologies, LP.
   b. GE Zenith Controls.
   c. Onan/Cummins Power Generation; Industrial Business Group.
   d. Russelectric, Inc.

2.2 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS

A. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 % of switch ampere rating, unless otherwise indicated.

B. Tested Fault-Current Closing and Withstand Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.

1. Where transfer switch includes internal fault-current protection, rating of switch and trip unit combination shall exceed indicated fault-current value at installation location.

C. Solid-State Controls: Repetitive accuracy of all settings shall be plus or minus 2 % or better over an operating temperature range of minus $20^0$C to plus $70^0$C.

D. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.

E. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric-motor-operated mechanism, mechanically and electrically interlocked in both directions.

F. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.

1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are not acceptable.
2. Switch Action: Double throw; mechanically held in both directions.
3. Contacts: Silver composition or silver alloy for load-current switching. Conventional automatic transfer-switch units, rated 225 A and higher, shall have separate arcing contacts.

G. Neutral Switching. All switches shall be four-pole switches , provide neutral pole switched simultaneously with phase poles.

H. Neutral Terminal: Solid and fully rated, unless otherwise indicated.

I. Annunciation, Control, and Programming Interface Components: Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels shall have communication capability matched with remote device. Provide CAT 6E cable in conduit from remote communication.

J. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, either by color-code or by numbered or lettered wire and cable tape markers at terminations. Color-coding and wire and cable tape markers are specified in Division 26 Section "Identification for Electrical Systems."

1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.
2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.

K. Enclosures: General-purpose NEMA 250, Type 1], complying with NEMA ICS 6 and UL 508, unless otherwise indicated

## 2.3 AUTOMATIC TRANSFER SWITCHES

A. Comply with Level 1 equipment according to NFPA 110.

B. Switching Arrangement: Double-throw type, incapable of pauses or intermediate position stops during normal functioning, unless otherwise indicated.

C. Manual Switch Operation: Under load, with door closed and with either or both sources energized. Transfer time is same as for electrical operation. Control circuit automatically disconnects from electrical operator during manual operation.

D. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval is adjustable from one (1) second to thirty (30) seconds.

E. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.

F. Transfer Switches Based on Molded-Case-Switch Components: Comply with NEMA AB 1, UL 489, and UL 869A.

G. Automatic Transfer-Switch Features:

1. Maximum operating transfer time of one sixth (1/6) second.
2. Undervoltage Sensing for Each Phase of Normal Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85% to 100 % of nominal, and dropout voltage is adjustable from 75% to 98 %of pickup value. Factory set for pickup at 95 % and dropout at 95 %.
3. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals. Adjustable from zero (0) seconds to six (6) seconds, and factory set for three (3) seconds.
4. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85% to 100 % of nominal. Factory set for pickup at 95 %. Pickup frequency shall be adjustable from 90% to 100% of nominal. Factory set for pickup at 98%.
5. Time delay for Transfer to Emergency: Adjustable from zero (0) minutes to five (5) minutes, and factory set for zero (0) minutes.
6. Time Delay for Retransfer to Normal Source: Adjustable from zero (0) minutes to thirty (30) minutes, and factory set for ten (10) minutes to automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
7. Engine Cool Down Time: Adjustable from zero (0) minutes to thirty (30) minutes, and factory set for five (5) minutes.
8. Test Switch: Simulate normal-source failure.
9. Switch-Position Pilot Lights: Indicate source to which load is connected.
10. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.

    a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
    b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."

11. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
12. Transfer Override Switch: Overrides automatic retransfer control so automatic transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.
13. Engine Starting Contacts: One (1) isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
14. Engine Shutdown Contacts: Time delay adjustable from zero (0) minutes to five (5) minutes, and factory set for five (5) minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.
15. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from seven (7) days to thirty (30) days. Running periods are adjustable from ten (10) minutes to thirty (30) minutes. Factory settings are for seven (7) day exercise cycle, thirty (30) minute running period, and five (5) minute cool-down period. Exerciser features include the following:

    a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
    b. Push-button programming control with digital display of settings.
    c. Integral battery operation of time switch when normal control power is not available.

## 2.4 SOURCE QUALITY CONTROL

A. Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

A. Floor-Mounting Switch: Anchor to floor by bolting.

1. Concrete Bases: Four (4) inches high, reinforced, with chamfered edges. Extend base no more than four (4) inches in all directions beyond the maximum dimensions of switch, unless otherwise indicated or. Construct concrete bases according to Division 26 Section "Hangers and Supports for Electrical Systems."

B. Identify components according to Division 26 Section "Identification for Electrical Systems."

C. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

D. Where generators serve more than one transfer switch, starting control is governed by the closing of engine start contacts at any one multiple transfer switches. Engines shall not shut down unless all associated transfer switches have transferred back to normal source and all cool-down time delays have expired.

## 3.2 CONNECTIONS

A. Wiring to Remote Components: Match type and number of cables and conductors to control and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.

B. Provide CAT 6E cable in conduit from ATS back to BAS main control panel.

C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

## 3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

B. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installation, including connections, and to assist in testing.
2. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
3. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
4. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.

a. Check for electrical continuity of circuits and for short circuits.
b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
c. Verify that manual transfer warnings are properly placed.
d. Perform manual transfer operation.

5. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.

a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
b. Simulate loss of phase-to-ground voltage for each phase of normal source.
c. Verify time-delay settings.
d. Verify pickup and dropout voltages by data readout or inspection of control settings.
e. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
f. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for one (1) pole deviating by more than 50 % from other poles.
g. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.

6. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.

a. Verify grounding connections and locations and ratings of sensors.

C. Coordinate tests with tests of generator and run them concurrently.

D. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

E. Remove and replace malfunctioning units and retest as specified above.

F. Infrared Scanning: After Substantial Completion, but not more than sixty (60) days after Substantial Completion, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.

1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch eleven (11) months after date of Substantial Completion.
2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

3. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

## 3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment as specified below. Refer to Division 01 Section "Demonstration and Training."

B. Coordinate this training with that for generator equipment.

## 3.5 START-UP SERVICES

A. The complete installation shall be initially started and checked for operational compliance by factory trained manufacturer's representative(s).

B. All settings, as specified in this section shall be property set and verified by start-up personnel.

C. Provide a written start-up and testing checklist which verifies all settings and features are properly set and functioning, written report shall indicate final setting of all adjustable features.

## 3.6 CLEANING

A. Upon completion of installation, inspect system components. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish. Clean components internally using methods and materials recommended by manufacturer.

END OF SECTION 263600

**SECTION 264113 - LIGHTNING PROTECTION FOR STRUCTURES**

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes lightning protection for buildings.

1.3 DEFINITIONS

A. LPI: Lightning Protection Institute.

B. NRTL: National recognized testing laboratory.

1.4 SUBMITTALS

A. Product Data: For air terminals and mounting accessories.

B. Shop Drawings: Detail lightning protection system, including air-terminal locations, conductor routing and connections, and bonding and grounding provisions. Include indications for use of raceway, data on how concealment requirements will be met, and calculations required by NFPA 780 for bonding of grounded and isolated metal bodies.

C. Qualification data for firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include data on listing or certification by an NRTL or LPI.

D. Certification, signed by Contractor, that roof adhesive for air terminals is approved by manufacturers of both the terminal assembly and the single-ply membrane roofing material.

E. Field inspection reports indicating compliance with specified requirements.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced installer who is an NRTL or who is certified by LPI as a Master Installer/Designer.

B. Listing and Labeling: As defined in NFPA 780, "Definitions" Article.

1.6 COORDINATION

A. Coordinate installation of lightning protection with installation of other building systems and components, including electrical wiring, supporting structures and building materials, metal bodies requiring bonding to lightning protection components, and building finishes.

B. Coordinate installation of air terminals attached to roof systems with roofing manufacturer and Installer.

## PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Automatic Lightning Protection.
2. ERICO International Corporation.
3. Harger Lightning Protection, Inc.
4. Heary Bros. Lightning Protection Co. Inc.
5. Independent Protection Co.
6. Robbins Lightning Inc.
7. Thompson Lightning Protection, Inc.

2.2 LIGHTNING PROTECTION SYSTEM COMPONENTS

A. Comply with UL 96.

B. Roof-Mounting Air Terminals: NFPA Class I aluminum, solid, unless otherwise indicated.

1. Single-Membrane, Roof-Mounting Air Terminals: Designed for single-membrane roof materials.

C. Ground Rods, Ground Loop Conductors, and Concrete-Encased Electrodes: Comply with Division 26 Section "Grounding and Bonding for Electrical Systems" and with standards referenced in this Section.

## PART 3 - EXECUTION

3.1 INSTALLATION

A. Install lightning protection components and systems according to UL 96A and NFPA 780.

B. Install conductors with direct paths from air terminals to ground connections. Avoid sharp bends and narrow loops.

C. Conceal the following conductors:

1. System conductors.
2. Down conductors.
3. Interior conductors.
4. Conductors within normal view from exterior locations at grade within 200 feet of building.
5. Notify Architect at least 48 hours in advance of inspection before concealing lightning protection components.

D. Cable Connections: Use approved exothermic-welded connections for all conductor splices and connections between conductors and other components, except those above single-ply membrane roofing.

E. Air Terminals on Single-Ply Membrane Roofing: Comply with adhesive manufacturer's written instructions.

F. Bond extremities of vertical metal bodies exceeding 60 feet in length to lightning protection components.

G. A counterpoise installation based on requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" may be used as a ground loop required by NFPA 780, provided counterpoise conductor meets or exceeds minimum requirements in NFPA 780.

1. Bond ground terminals to counterpoise conductor.
2. Bond grounded metal bodies on building within 12 feet of ground to counterpoise conductor.
3. Bond grounded metal bodies on building within 12 feet of roof to counterpoise conductor.

H. Bond lightning protection components with intermediate-level interconnection loop conductors to grounded metal bodies of building at 60-foot intervals.

3.2 CORROSION PROTECTION

A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.

B. Use conductors with protective coatings where conditions would cause deterioration or corrosion of conductors.

3.3 FIELD QUALITY CONTROL

A. UL Inspection: Provide inspections as required to obtain a UL Master Label for system.

B. Provide an inspection by an inspector certified by LPI to obtain an LPI certification.

END OF SECTION 264113

# SECTION 265100 - INTERIOR LIGHTING

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

1.2 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 26.

### 1.3 SUMMARY

A. Section Includes:

1. Interior lighting fixtures, lamps, and ballasts.
2. Emergency lighting units.
3. Exit signs.
4. Lighting fixture supports.
5.

### 1.4 DEFINITIONS

A. BF: Ballast factor.

B. CCT: Correlated color temperature.

C. CRI: Color-rendering index.

D. HID: High-intensity discharge.

E. LER: Luminaire efficacy rating.

F. Lumen: Measured output of lamp and luminaire, or both.

G. Luminaire: Complete lighting fixture, including ballast housing if provided.

### 1.5 SUBMITTALS

A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:

1. Physical description of lighting fixture including dimensions.
2. Emergency lighting units including battery and charger.
3. Ballast, including BF.
4. Lamps
5. Energy-efficiency data.
6. Life, output (lumens, CCT, and CRI), and energy-efficiency data for lamps.

    a. Manufacturer Certified Data: Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Shop Drawings: For nonstandard or custom lighting fixtures. Include plans, elevations, sections, details, and attachments to other work.

    1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

C. Shop Drawings: All lighting fixtures shall include the following, in addition to the requirements of the Submittal section:

    1. Wiring Diagrams: For power, signal, and control wiring.

D. Samples: For each custom lighting fixture indicated in the Interior Lighting Fixture Schedule. Each Sample shall include the following:

    1. Lamps and ballasts, installed.
    2. Cords and plugs.
    3. Pendant support system.

E. Installation instructions.

F. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

    1. Lighting fixtures.
    2. Suspended ceiling components.
    3. Partitions and millwork that penetrate the ceiling or extends to within twelve (12) inches of the plane of the luminaires.
    4. Ceiling-mounted projectors.
    5. Structural members to which suspension systems for lighting fixtures will be attached.
    6. Other items in finished ceiling including the following:

        a. Air outlets and inlets.

b. Speakers.
c. Sprinklers.
d. Smoke and fire detectors.
e. Occupancy sensors.
f. Access panels.
g.

7. Perimeter moldings.

G. Qualification Data: For qualified agencies providing photometric data for lighting fixtures.

H. Product Certificates: For each type of ballast for bi-level and dimmer-controlled fixtures, from manufacturer.

I. Field quality-control reports.

J. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.

1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

K. Warranty: Sample of special warranty.

## 1.6 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910, complying with the IESNA Lighting Measurements Testing & Calculation Guides.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NFPA 70.

D. Mockups: Provide interior lighting fixtures for room or module mockups, complete with power and control connections.

1. Obtain Architect's approval of fixtures for mockups before starting installations.
2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.

## 1.7 COORDINATION

A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

## 1.8 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamps: Ten (10) for every one hundred (100) of each type and rating installed. Furnish at least one (1) of each type.
2. Plastic Diffusers and Lenses: One (1) for every one hundred (100) of each type and rating installed. Furnish at least one (1) of each type.
3. Fluorescent-fixture-mounted, emergency battery pack: One (1) for every twenty (20) emergency lighting unit.
4. Ballasts: One (1) for every one hundred (100) of each type and rating installed. Furnish at least one (1) of each type.
5. Globes and Guards: One (1) for every twenty (20) of each type and rating installed. Furnish at least one (1) of each type.

## 1.9 WARRANTY/GUARANTEE

A. See Division 26 Specification Section “Basic Electrical Requirements’ for warranty and guarantee requirements.

B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of surge suppressors that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five (5) years from date of Substantial Completion.

C. Special Warranty for Cord-Connected, Plug-in Surge Suppressors: Manufacturer's standard form in which manufacturer agrees to repair or replace electronic equipment connected to circuits protected by surge suppressors.

D. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Emergency Lighting Unit Batteries: Ten (10) years from date of Substantial Completion. Full warranty shall apply for two (2) years, and prorated warranty for the remaining eight (8) years.

2. Warranty Period for Self-Powered Exit Sign Batteries: Seven (7) years from date of Substantial Completion. Full warranty shall apply for two (2) years, and prorated warranty for the remaining five (5) years.

## PART 2 - PRODUCTS

### 2.1 GENERAL REQIREMENTS

A. Refer to lighting fixture schedule on contract drawings for requirements.

### 2.2 LIGHTING FIXTURE SUPPORT COMPONENTS

A. Comply with Division 26 Section "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: One half (1/2) inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.

C. Twin-Stem Hangers: Two (2), one half (1/2) inch steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.

D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage.

E. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gauge.

F. Rod Hangers: Three sixteenth (3/16) inch minimum diameter, cadmium-plated, threaded steel rod.

G. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Lighting fixtures:

1. Set level, plumb, and square with ceilings and walls unless otherwise indicated.
2. Install lamps in each luminaire.

B. Lay-in Ceiling Lighting Fixtures Supports: Use grid as a support element.

1. Install ceiling support system rods or wires, independent of the ceiling suspension devices, for each fixture. Locate not more than six (6) inches from lighting fixture corners.
2. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two (2) three quarter (3/4) inch metal channels spanning and secured to ceiling tees.

C. Suspended Lighting Fixture Support:

1. Pendants and Rods: Where longer than forty eight (48) inches, brace to limit swinging.
2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.
4. Do not use grid as support for pendant luminaires. Connect support wires or rods to building structure.

D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

## 3.2 IDENTIFICATION

A. Install labels with panel and circuit numbers on concealed junction and outlet boxes. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems.

## 3.3 FIELD QUALITY CONTROL

A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.

B. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

END OF SECTION 265100

# SECTION 265600 - EXTERIOR LIGHTING

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 26.

### 1.2 SUMMARY

A. Section Includes:

1. Exterior luminaires with lamps and ballasts.
2. Luminaire-mounted photoelectric relays.
3. Poles and accessories.

### 1.3 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color-rendering index.

C. HID: High-intensity discharge.

D. LER: Luminaire efficacy rating.

E. Luminaire: Complete lighting fixture, including ballast housing if provided.

F. Pole: Luminaire support structure, including tower used for large area illumination.

G. Standard: Same definition as "Pole" above.

### 1.4 SUBMITTALS

A. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:

1. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.
2. Details of attaching luminaires and accessories.
3. Details of installation and construction.
4. Luminaire materials.
5. Photometric data based on laboratory tests of each luminaire type, complete with indicated lamps, ballasts, and accessories.
6. Voltage drop calculations.

    a. Manufacturer Certified Data: Photometric data shall be certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

7. Photoelectric relays.
8. Ballasts, including energy-efficiency data.
9. Lamps, including life, output, CCT, CRI, lumens, and energy-efficiency data.
10. Materials, dimensions, and finishes of poles.
11. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.
12. Anchor bolts for poles.
13. Pole foundations

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Anchor-bolt templates keyed to specific poles and certified by manufacturer.
3. Design calculations, certified by a qualified professional engineer, indicating strength of foundations and soil conditions on which they are based.
4. Wiring Diagrams: For power, signal, and control wiring.

C. Qualification Data: For qualified agencies providing photometric data for lighting fixtures.

D. Field quality-control reports.

E. Operation and Maintenance Data: For luminaires to include in emergency, operation, and maintenance manuals. Provide data in electronic and hard-copy formats.

F. Warranty: Sample of special warranty specified in this section

G. Coordination Drawings: Provide coordination drawings by coordination with Civil and other trades.

## 1.5 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratory that is accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency acceptable to the authority having jurisdiction, and marked for intended location and application.

C. Comply with IEEE C2, "National Electrical Safety Code."

D. Comply with NFPA 70.

## 1.6 DELIVERY, STORAGE, AND HANDLING

A. Package aluminum poles for shipping according to ASTM B 660.

B. Store poles on decay-resistant-treated skids at least twelve (12) inches above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.

C. Retain factory-applied pole wrappings on metal poles until right before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

## 1.7 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamps: One (1) for every one hundred (100) of each type and rating installed. Furnish at least one (1) of each type.
2. Glass and Plastic Lenses, Covers, and Other Optical Parts: One (1) for every one hundred (100) of each type and rating installed. Furnish at least one (1) of each type.
3. Ballasts: One (1) for every one hundred (100) of each type and rating installed. Furnish at least one (1) of each type.
4. Globes and Guards: One (1) for every twenty (20) of each type and rating installed. Furnish at least one (1) of each type.

## 1.8 WARRANTY/GUARANTEE

A. See Division 26 Specification Section “Basic Electrical Requirements’ for warranty and guarantee requirements.

B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.

1. Warranty Period for Luminaires: Five (5) years from date of Substantial Completion.
2. Warranty Period for Metal Corrosion: Five (5) years from date of Substantial Completion.
3. Warranty Period for Color Retention: Five (5) years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 GENERAL REQUIREMENTS

A. Refer to lighting fixture schedule on contract drawings for requirements.

### 2.2 GENERAL REQUIREMENTS FOR SUPPORT COMPONENTS

A. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.

B. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.

1. Materials: Shall not cause galvanic action at contact points.
2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.
3. Anchor-Bolt Template: Plywood or steel.

## PART 3 - EXECUTION

### 3.1 LUMINAIRE INSTALLATION

A. Install lamps in each luminaire.

B. Fasten luminaire to indicated structural supports.

C. Adjust luminaires that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources, favoring a north orientation.

## 3.2 CORROSION PREVENTION

A. Steel Conduits: Comply with Division 26 Section "Raceway and Boxes for Electrical Systems."

## 3.3 GROUNDING

A. Ground metal poles and support structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."

1. Install grounding electrode for each pole unless otherwise indicated.
2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

## 3.4 FIELD QUALITY CONTROL

A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

B. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.

1. Verify operation of photoelectric controls.

C. Illumination Tests:

1. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IESNA testing guide(s):

a. IESNA LM-5, "Photometric Measurements of Area and Sports Lighting Installations."
b. IESNA LM-50, "Photometric Measurements of Roadway Lighting Installations."
c. IESNA LM-52, "Photometric Measurements of Roadway Sign Installations."
d. IESNA LM-64, "Photometric Measurements of Parking Areas."
e. IESNA LM-72, "Directional Positioning of Photometric Data."

D. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

END OF SECTION 265600

# SECTION 270544 - SLEEVES AND SLEEVE SEALS FOR COMMUNICATIONS PATHWAYS AND CABLING

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 27.

### 1.2 SUMMARY

A. Section Includes:

1. Sleeves for pathway and cable penetration of non-fire-rated construction walls and floors.
2. Sleeve-seal systems.
3. Sleeve-seal fittings.
4. Grout.
5. Silicone sealants.

### 1.3 ACTION SUBMITTALS

A. Product Data: For each type of product specified in this section.

### 1.4 WARRANTY/GUARANTEE

A. See Division 26 Specification Section “Basic Electrical Requirements’ for warranty and guarantee requirements.

## PART 2 - PRODUCTS

### 2.1 SLEEVES

A. Wall Sleeves:

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

C. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

D. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

E. Sleeves for Rectangular Openings:

1. Material: Galvanized-steel sheet.
2. Minimum Metal Thickness:

a. For sleeve cross-section rectangle perimeter less than fifty (50) inches and with no side larger than sixteen (16) inches, thickness shall be 0.052 inch.
b. For sleeve cross-section rectangle perimeter fifty (50) inches or more and one or more sides larger than sixteen (16) inches, thickness shall be 0.138 inch.

## 2.2 SLEEVE-SEAL SYSTEMS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and pathway or cable.

1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

a. Advance Products & Systems, Inc.
b. CALPICO, Inc.
c. Metraflex Company (The).
d. Pipeline Seal and Insulator, Inc.
e. Proco Products, Inc.

2. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
3. Pressure Plates: Stainless steel.
4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

## 2.3 SLEEVE-SEAL FITTINGS

A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.

a. Manufacturers: Subject to compliance with requirements, provide products by the following Pre-sealed Systems.

2.4 GROUT

A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.

B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

C. Design Mix: 5,000-psi, twenty eight (28) day compressive strength.

D. Packaging: Premixed and factory packaged.

2.5 SILICONE SEALANTS

A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
2. Sealant shall have VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

**PART 3 - EXECUTION**

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Comply with NECA 1.

B. Comply with NEMA VE 2 for cable tray and cable penetrations.

C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:

1. Interior Penetrations of Non-Fire-Rated Walls and Floors:

a. Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants."
b. Seal space outside of sleeves with mortar, grout, or silicone. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.

2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
3. Size pipe sleeves to provide one quarter (1/4) inch annular clear space between sleeve and pathway or cable unless sleeve seal is to be installed.
4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. De-burr after cutting.
5. Install sleeves for floor penetrations. Extend sleeves installed in floors two (2) inches above finished floor level. Install sleeves during erection of floors.

D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:

1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.

E. Roof-Penetration Sleeves: Seal penetration of individual pathways and cables with flexible boot-type flashing units applied in coordination with roofing work to maintain any existing warranties.

F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using PVC or steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for one (1) inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

G. Underground, Exterior-Wall and Floor Penetrations: Install PVC, steel sleeves. Size sleeves to allow for one (1) inch annular clear space between pathway or cable and sleeve for installing sleeve-seal system.

## 3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at pathway entries into building.

B. Install type and number of sealing elements recommended by manufacturer for pathway or cable material and size. Position pathway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pathway or cable and sleeve.

Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

## 3.3 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 270544

# SECTION 271100 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 27.

### 1.2 SUMMARY

A. Section Includes:

1. Telecommunications mounting elements.
2. Backboards.
3. Telecommunications equipment racks and cabinets.
4. Telecommunications service entrance pathways.
5. Grounding.

### 1.3 DEFINITIONS

A. Basket Cable Tray: A fabricated structure consisting of wire mesh bottom and side rails.

B. BICSI: Building Industry Consulting Service International.

C. Channel Cable Tray: A fabricated structure consisting of a one-piece, ventilated-bottom or solid-bottom channel not exceeding 6 inches in width.

D. Ladder Cable Tray: A fabricated structure consisting of two longitudinal side rails connected by individual transverse members (rungs).

E. LAN: Local area network.

F. RCDD: Registered Communications Distribution Designer.

G. Solid-Bottom or Non-ventilated Cable Tray: A fabricated structure consisting of a bottom without ventilation openings within integral or separate longitudinal side rails.

H. Trough or Ventilated Cable Tray: A fabricated structure consisting of integral or separate longitudinal rails and a bottom having openings sufficient for the passage of air and using 75 percent or less of the plan area of the surface to support cables.

1.4 SUBMITTALS

A. Product Data: For each type of product specified in this section. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for equipment racks and cabinets. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For communications equipment room fittings. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.
3. Grounding: Indicate location of grounding bus bar and its mounting detail showing standoff insulators and wall mounting brackets.

C. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installers must be Level 2 certified by BICSI.

1. Layout Responsibility: Preparation of Shop Drawings shall be under the direct supervision of RCDD/NTS.
2. Installation Supervision: Installation shall be under the direct supervision of Registered Technician, who shall be present at all times when Work of this Section is performed at Project site.
3. Field Inspector: Currently registered by BICSI as RCDD to perform the on-site inspection.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Telecommunications Pathways and Spaces: Comply with TIA/EIA- 568 C.

D. Grounding: Comply with ANSI-J-STD- 568 C.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install equipment frames and cable trays until spaces are enclosed and weather-tight, wet work in spaces is complete and dry, and work above ceilings is complete.

1.7 COORDINATION

A. Coordinate layout and installation of communications equipment with owner's telecommunications and LAN equipment and service suppliers. Coordinate service entrance arrangement with local exchange carrier.

1. Meet jointly with telecommunications and LAN equipment suppliers, local exchange carrier representatives, and owner to exchange information and agree on details of equipment arrangements and installation interfaces.
2. Record agreements reached in meetings and distribute them to other participants.
3. Adjust arrangements and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize arrangement and space requirements of telephone switch and LAN equipment.
4. Adjust arrangements and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in the equipment room.

B. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

1.8 WARRANTY/GUARANTEE

A. See Division 26 Specification Section “Basic Electrical Requirements’ for warranty and guarantee requirements.

**PART 2 - PRODUCTS**

2.1 PATHWAYS

A. General Requirements: Comply with TIA/EIA-568 C.

B. Cable Support: NRTL labeled. Cable support brackets shall be designed to prevent degradation of cable performance and pinch points that could damage cable.

1. Comply with NFPA 70 and UL 2043 for fire-resistant and low-smoke-producing characteristics.

2. B20 mushroom spools and white backboards as manufactured by AllenTel, catalog #187D1 (single) or 187B1 (double),
3. Five (5) inch wide x three and one quarter (3.25) inch high D-rings as manufactured by CPI, catalog #10943-000 or equivalent.
4. Blue backboards for mounting sixty six (66) blocks shall be manufactured by AllenTel, catalog #GB183B1 or equivalent.
5. Velcro straps for Cat 6 cable and other devices.

C. Cable Trays:

1. Cable Trays: Comply with NEMA VE 2 and TIA/EIA We can give the more global spec section 569 C.

2. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

a. Cable Management Solutions, Inc.
b. Cablofil Inc.
c. Cooper B-Line, Inc.
d. Cope - Tyco/Allied Tube & Conduit.
e. CPI
f. Wiremold Spec-Mate, Catalog #CA 04 09 18.

3. Cable Tray Materials: Aluminum.

a. Ladder Cable Trays: Nominally eighteen (18) inches wide, and a rung spacing of nine (9) inches.

D. Conduit and Boxes: Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems." Flexible metal conduit shall not be used.

1. Outlet boxes shall be no smaller than two (2) inches wide, three (3) inches high, and two and one half (2-1/2) inches deep.

## 2.2 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, three quarter (3/4) inches by forty eight (48) inches by ninety six (96) inches. Comply with requirements for plywood backing panels specified in Division 06 Section "Rough Carpentry."

## 2.3 EQUIPMENT FRAMES

A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. Chatsworth Products Incorporated, CPI, Catalog #55053-703.
2. Ortronics, Inc.
3. Siemon Co. (The).

B. General Frame Requirements:

1. Distribution Frames: Nineteen (19) inches wide freestanding, unit designed for telecommunications terminal support.
2. Module Dimension: Width compatible with EIA 310 standard, nineteen (9) inch panel mounting.
3. Finish: Black, baked-polyester powder coat.

C. Finish: Black, Modular Freestanding Cabinets:

1. Removable and lockable side panels.
2. Hinged and lockable front and rear doors.
3. Adjustable feet for leveling.
4. Screened ventilation openings in the roof and rear door.
5. Cable access provisions in the roof and base.
6. Grounding bus bar.
7. Rack-mounted, 550-cfm fan with filter. Power strip.
8. Finish: Black, All cabinets keyed alike.

D. Cable Management for Equipment Frames:

1. Metal, with integral wire retaining fingers.
2. Finish: Black.
3. Double-side vertical trough with lockable cable latches, protective edge guards and pass-through ports; as manufactured by CPI, Catalog #11729-703 or UMB CITS approved equivalent.
4. Provide horizontal crossover cable manager at the top of each relay rack, with a minimum height of one rack unit each. As manufactured by Ortronics, Catalog # OR-808004759 or UMB CITS approved equivalent.

## 2.4 POWER STRIPS

A. Power Strips: Comply with UL 1363.

1. Rack mounting (or field installed).
2. Six 20-A, 120-V ac, NEMA WD 6, Configuration 5-20R receptacles.
3. LED indicator lights for power and protection status.
4. Circuit Breaker and Thermal Fusing: Unit continues to supply power if protection is lost.
5. [Close-coupled, direct plug-in] [Cord connected with fifteen (15) foot] line cord.
6. Rocker-type on-off switch, illuminated when in on position.

2.5 GROUNDING

A. Comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems." for grounding conductors and connectors.

B. Telecommunications Main Bus Bar:

1. Connectors: Mechanical type, cast silicon bronze, solderless compression type wire terminals, and long-barrel, two-bolt connection to ground bus bar.
2. Ground Bus Bar: Copper, minimum one quarter (1/4) inch thick by four (4) inches wide with nine thirty second (9/32) inch holes spaced one and one eighth (1-1/8) inches apart.
3. Stand-Off Insulators: Comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5,000 V.

C. Comply with ANSI-J-STD- 568 C

2.6 LABELING

A. Comply with TIA/EIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

**PART 3 - EXECUTION**

3.1 ENTRANCE FACILITIES

A. Contact telecommunications service provider and arrange for installation of demarcation point, protected entrance terminals, and housing when so directed by service provider.

B. Install undergroundpathways complying with recommendations in TIA/EIA- 569C "Entrance Facilities" Article.

3.2 Install undergroundentrance pathway complying with Division 26 Section "Raceway and Boxes for Electrical Systems.

A. Comply with NECA 1.

B. Comply with BICSI TDMM for layout and installation of communications equipment rooms.

C. Cable Trays: Comply with NEMA VE 2 and TIA/EIA 569 C.

D. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

3.3 FIRESTOPPING

A. Comply with requirements in Division 07 Section "Penetration Firestopping."Comply with TIA/EIA-569-A; Annex A, "Firestopping."

B. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.4 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with ANSI-J-STD- 568 C.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

1. Bond the shield of shielded cable to the grounding bus bar in communications rooms and spaces.

3.5 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements in Division 26 Section "Identification for Electrical Systems."Comply with requirements in Division 09 Section "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

B. See Division 27 Section "Communications Horizontal Cabling" for additional identification requirements.

C. Labels shall be preprinted or computer-printed type.

END OF SECTION 271100

# SECTION 271300 - COMMUNICATIONS BACKBONE CABLING (INTER & INTRA-BUILDING)

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 27.

### 1.2 SUMMARY

A. Section Includes:

1. Pathways.
2. UTP cable.
3. 62.5/125 Multi-mode, and Single-mode optical fiber cabling.
4. Cable connecting hardware, patch panels, and cross-connects.
5. Cabling identification products.

B. Related Sections:

1. Division 27 Section “Communications Equipment Room Fittings”.

### 1.3 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

C. EMI: Electromagnetic interference.

D. IDC: Insulation displacement connector.

E. LAN: Local area network.

F. RCDD: Registered Communications Distribution Designer.

G. UTP: Unshielded twisted pair.

## 1.4 BACKBONE CABLING DESCRIPTION

A. Backbone cabling system shall provide interconnections between buildings and between communications equipment rooms within buildings. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.

B. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters shall not be used as part of backbone cabling.

## 1.5 PERFORMANCE REQUIREMENTS

A. General Performance: Backbone cabling system shall comply with transmission standards in TIA/EIA-568-C, when tested according to test procedures of this standard.

## 1.6 SUBMITTALS

A. Product Data: For each type of product specified in this section.

B. Shop Drawings:

1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
2. Cabling administration drawings and printouts.
3. Wiring diagrams to show typical wiring schematics including the following:

    a. Cross-connects.
    b. Patch panels.
    c. Patch cords.
    d. Cable path between buildings.

4. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.
5. Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:

    a. Vertical and horizontal offsets and transitions.
    b. Clearances for access above and to side of cable trays.
    c. Vertical elevation of cable trays above the floor or bottom of ceiling structure.
    d. Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.

C. Qualification Data: For Installer, qualified layout technician, installation supervisor, field inspector, and RCDD.

D. Source quality-control reports.

E. Field quality-control reports.

F. Maintenance Data: For splices and connectors to include in maintenance manuals.

## 1.7 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff. RCDD, testers, and installers shall be certified by the manufacturer of the product being installed.

1. Layout Responsibility: Preparation of Shop Drawings, Cabling Administration Drawings, and field testing program development by an RCDD.

2. Installation Supervision: Installation shall be under the direct supervision of RCDD, who shall be present at all times when Work of this Section is performed at Project site.

3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 450 or less.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-B-2004.

E. Grounding: Comply with ANSI-J-STD-607-A-2002, and all applicable sections of NFPA 70, NEC.

## 1.8 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Test optical fiber cable while on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector, including the loss value of each. Retain test data and include the record in maintenance data.
2. Test each pair of UTP cable for open and short circuits.

1.9 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces (including Maintenance holes) is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

B. Drywall, sanding, drilling, and painting of all surfaces shall be completed before installing cable in equipment rooms and maintenance holes.

1.10 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

1.11 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Patch-Panel Units: One (1) of each type.
2. Connecting Blocks: One (1) of each type.
3. Solid state digital surge protection modules (Circa 4B1S-300**)**

1.12 WARRANTY/GUARANTEE

A. See Division 26 Specification Section “Basic Electrical Requirements’ for warranty and guarantee requirements.

**PART 2 - PRODUCTS**

2.1 PATHWAYS

A. General Requirements: Comply with TIA/EIA-569-B-2004.

B. Cable Support: NRTL labeled for support of Category 6 cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.

1. Support brackets with cable tie slots for fastening cable ties to brackets.
2. Lacing bars, spools, J-hooks, and D-rings.
3. Straps and other devices.
4. Velcro straps

C. Cable Trays:

1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

a. Cable Management Solutions, Inc.
b. Cooper B-Line, Inc.
c. Cope - Tyco/Allied Tube & Conduit.
d. Wiremold Spec-Mate, Catalog #CA 04 09 18.

2. Cable Tray Material: Metal, suitable for indoors and protected against corrosion by hot dipped galvanizing, complying with ASTM A 123/A 123M, Grade 055, not less than 0.002165 inch thick steel, or Aluminum.

a. Ladder Cable Trays: Nominally eighteen (18) inches wide, and a rung spacing of nine (9) inches.

D. Conduit and Boxes: Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems." Flexible metal conduit shall not be used.

1. Outlet boxes shall be no smaller than two (2) inches wide, four (4) inches high and two and one half (2-1/2) inches deep.

## 2.2 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, three quarter (3/4) inches by forty eight (48) inches by ninety six (96) inches. Comply with requirements in Division 06 Section "Rough Carpentry" for plywood backing panels.

## 2.3 UTP CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
1. Berk-Tek; a Nexans company.
2. CommScope, Inc.
3. Superior Essex Inc.
4. General Cable.

5. Mohawk
6. Siemen
7. Ortronics

B. OSP Description: 100 ohm twisted pair OSP cable. 24 AWG, solid copper conductors, 100-pair UTP, formed into 25-pair binder groups covered with a thermoplastic jacket and overall metallic shield, Gel filled OSP rated,
   1. Comply with ICEA S-84-608-2007 Gel Filled OSP Copper standard
   2. Comply with ANSI/TIA/EIA-758-A-2004 Standard for OSP

C. Riser Description: 24 AWG, solid copper conductors, 100-ohm, twenty five (25) pair UTP, formed into twenty five (25) pair binder groups covered with a gray thermoplastic jacket (unless this is installed in any part outside the closet riser sleeves and into the open ceiling spaces/cable trays between tele/data rooms in which case a plenum jacket will be required). Category 5e or 6e.

   1. Comply with ICEA S-90-661 for mechanical electrical and flammability requirements.
   2. Comply with TIA/EIA-568-C
   3. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:

      a. Communications, Plenum Rated: Type CMP complying with NFPA 262.
      b. Communications, Riser Rated: Type CMR complying with UL 1666.

## 2.4 UTP CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
   1. Siemon Co. (Data - Cat 6).
   2. AllenTel (Voice - Cat 5e).

B. General Requirements for Cable Connecting Hardware: Comply with TIA/EIA-568-B.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.

C. Voice Connecting Blocks: 66-style IDC for Category 5e. Provide blocks for the number of cables terminated on the block, plus 25 % spare. Integral with connector bodies, including plugs and jacks where indicated. As manufactured by AllenTel, Catalog #S66M1-50 with S89B standoff brackets and 183B1 blue backboards; or approved equivalent.

   1. Number of Terminals per Field: One (1) for each conductor in assigned cables.

D. Data Patch Panel: Cat 6 modular forty eight (48) port panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair

groups of installed cables. As manufactured by The Siemon Company, Ortronics, Catalog #HD-48 high density.

1. Number of Jacks per Field: One for each four-pair conductor group of indicated cables, plus spares and blank positions adequate to suit specified expansion criteria.

E. Jacks and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.

F. Patch Cords: Factory-made, four (4) pair cables in thirty six (36) inchlengths; terminated with eight (8) position modular plug at each end.

1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure Category 6 performance. Patch cords shall have latch guards to protect against snagging.
2. Patch cords shall have color-coded boots for circuit identification.

## 2.5 OPTICAL FIBER CABLE

A. Description: Hybrid inter-building cable shall contain both multimode and Single mode fibers under a single plenum jacket containing an armored fiber as manufactured by OCC, Catalog #DX036-090D-24WLS-12SLX-900-CST.

1. Multimode: 62.5/125-micrometer, 24-fiber, nonconductive, tight buffer with aramid yarn strength member (i.e. Kevlar™), plenum jacket, indoor/outdoor rated (-20$^0$C to +85$^0$C), optical fiber cable. 900 µm buffer diameter, numerical aperture 0.29 +/- 0.02, minimum bandwidth of 200 MHz at 850 nm, 500 MHz at 1300 nm, maximum attenuation 3.5 dB/km at 850 nm and 1.5 dB/km at 1300 nm.

2. Single Mode: 9/125-micrometer, 12-fiber, nonconductive, tight buffer with aramid yarn strength member (i.e. Kevlar™), plenum jacket, indoor/outdoor rated (-20$^0$C to +85$^0$C), optical fiber cable. 8-9 µm core diameter, and 125 µm cladding diameter, maximum attenuation 1.0 dB/km at 1310 nm and 1.0 dB/km at 1550 nm.

3. Comply with ICEA S-83-596 for indoor cable and S-87-640 for mechanical properties on outside plant cables.
4. Comply with TIA/EIA-568-B.3 for performance specifications.
5. Comply with TIA/EIA-492AAAA-A for detailed specifications.
6. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:

   a. General Purpose, Nonconductive: Type OFN or OFNG , or OFNR, OFNP.
   b. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.

c. Riser Rated, Nonconductive: Type OFNR or OFNP, complying with UL 1666.

B. Jacket:

1. Jacket Color: Orange for 62.5/125-micrometer cable.
2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA/EIA-598-B.
3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed forty (40) inches.

C. Description: Hybrid intra-building cable shall contain both multimode and Single mode fibers under a single plenum jacket, as manufactured by OCC, Catalog # GX036-090D-24WLS-12SLX-900-CST.

1. Multimode: 62.5/125-micrometer, 24-fiber, nonconductive, tight buffer with aramid yarn strength member (i.e. Kevlar™), plenum jacket, indoor/outdoor rated ($-20^0$C to $+65^0$C), optical fiber cable. 900 µm buffer diameter, numerical aperture 0.29 +/- 0.02, minimum bandwidth of 200 MHz at 850 nm, 500 MHz at 1300 nm, maximum attenuation 3.5 dB/km at 850 nm and 1.5 dB/km at 1300 nm.

2. Single Mode: 9/125-micrometer, 12-fiber, nonconductive, tight buffer with aramid yarn strength member (i.e. Kevlar™), plenum jacket, indoor/outdoor rated ($-20^0$C to $+65^0$C), optical fiber cable. 8-9 µm core diameter, and 125 µm cladding diameter, maximum attenuation 1.0 dB/km at 1310 nm and 1.0 dB/km at 1550 nm.

## 2.6 OPTICAL FIBER CABLE HARDWARE

A. Cross-Connects and Patch Panels: Rack mounted, modular patch panels with hinged front doors, mounting guides and designated coupler panels housing multiple-numbered SC connectors; as manufactured by Siecor/Corning, catalog #CCH-CP12-59.

1. Number of Connectors per Field: Onefor each fiber of cable or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.

B. Patch Cords: Factory-made, dual-fiber cables in 36-inch lengths.

1. Multimode: 62.5/125um, zipcord cable with an orange jacket. Shall support all bandwidths, dual-window and low-loss. As manufactured by Lucent/Avaya (or approved equal), catalog #9191-02K5141-XXX-M; where XXX equals maximum length.

2. Single mode: 8-9/125um, zipcord cable with an yellow jacket. Shall support all bandwidths, dual-window and low-loss. As manufactured by Lucent/Avaya (or

approved equal), catalog #9191-02R5131-XXX-M; where XXX equals maximum length.

C. Cable Connecting Hardware:

1. Comply with Optical Fiber Connector Intermateability Standards (FOCIS) specifications of TIA/EIA-604-2, TIA/EIA-604-3-A, and TIA/EIA-604-12. Comply with TIA/EIA-568-B.3.
2. Quick-connect, simplex and duplex, Type SC connectors. Insertion loss not more than 0.75 dB, as manufactured by Siemon, catalog #CT-SC-4-02.

## 2.7 GROUNDING

A. Comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems." for grounding conductors and connectors.

B. Comply with ANSI-J-STD-607-A.

## 2.8 IDENTIFICATION PRODUCTS

A. Comply with TIA/EIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

## 2.9 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test cables on reels according to TIA/EIA-568-B.1.

C. Factory test UTP cables according to TIA/EIA-568-B.2.

D. Factory test multimode optical fiber cables according to TIA/EIA-526-14-A and TIA/EIA-568-B.3.

E. Cable will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

## PART 3 - EXECUTION

### 3.1 WIRING METHODS

A. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters. Conceal raceway and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with requirements for raceways and boxes specified in Division 26 Section "Raceway and Boxes for Electrical Systems."

B. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

### 3.2 INSTALLATION OF PATHWAYS

A. Cable Trays: Comply with NEMA VE 2 and TIA/EIA-569-A.

B. Comply with requirements for demarcation point, pathways, cabinets, and racks specified in Division 27 Section "Communications Equipment Room Fittings." Drawings indicate general arrangement of pathways and fittings.

C. Comply with TIA/EIA-569-A for pull-box sizing and length of conduit and number of bends between pull points.

D. Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems" for installation of conduits and wireways.

E. Install manufactured conduit sweeps and long-radius elbows whenever possible.

F. Pathway Installation in Communications Equipment Rooms:

1. Position conduit ends adjacent to a corner on backboard where a single piece of plywood is installed, or in the corner of room where multiple sheets of plywood are installed around perimeter walls of room.
2. Install cable trays to route cables if conduits cannot be located in these positions.
3. Secure conduits to backboard when entering room from overhead.
4. Extend conduits 3 inchesabove finished floor.
5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

G. Backboards: Install backboards with ninety six (96) inch dimension vertical. Butt adjacent sheets tightly, and form smooth gap-free corners and joints.

3.3 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with TIA/EIA-568-B.1.
2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
3. Install 110-style IDC termination hardware unless otherwise indicated.
4. Terminate all conductors; no cable shall contain un-terminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
5. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than six (6) inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
6. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
7. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.
8. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
9. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
10. In the communications equipment room, install a ten (10) foot- long service loop on each end of cable.
11. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

C. UTP Cable Installation:

1. Comply with TIA/EIA-568-B.2.
2. Do not untwist UTP cables more than one half (1/2) inch from the point of termination to maintain cable geometry.

D. Optical Fiber Cable Installation:

1. Comply with TIA/EIA-568-B.3.
2. Cable may be terminated on connecting hardware that is rack or cabinet mounted.

E. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.

2. Suspend UTP cable not in a wireway or pathway, a minimum of 8 inches above ceilings by cable supports not more than sixty (60) inchesapart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

F. Installation of Cable Routed Exposed under Raised Floors:

1. Install plenum-rated cable only.
2. Install cabling after the flooring system has been installed in raised floor areas.
3. Coil cable six (6) feetlong not less than twelve (12) inchesin diameter below each feed point.

G. Group connecting hardware for cables into separate logical fields.

H. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA/EIA-569-A recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: A minimum of five (5) inches.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of twelve (12) inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of twenty four (24) inches.

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: A minimum of two and one half (2-1/2) inches.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of six (6) inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of twelve (12) inches.

4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: No requirement.

b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of three (3) inches.
c. Electrical Equipment Rating More Than 5 kVA: A minimum of six (6) inches.

5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of forty eight (48) inches.
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of five (5) inches.

## 3.4 FIRESTOPPING

A. Comply with requirements in Division 07 Section "Penetration Firestopping."Comply with TIA/EIA-569-A, Annex A, "Firestopping."

B. Comply with BICSI TDMM, "Firestopping Systems" Article.

## 3.5 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with ANSI-J-STD-607-A.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least two (2) inch clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

## 3.6 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

1. Administration Class: 3.
2. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.

B. Comply with requirements in Division 09 Section "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

C. Comply with requirements in Division 27 Section "Communications Horizontal Cabling" for cable and asset management software.

D. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

E. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.

F. Cable and Wire Identification:

1. Label each cable within four (4) inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding fifteen (15) feet.
4. Label each terminal strip and screw terminal in each cabinet, rack, or panel.

    a. Individually number the wiring conductors connected to terminal strips and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device with name and number of particular device as shown.
    b. Label each unit and field within distribution racks and frames.

5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

G. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA/EIA 606-A, for the following:

1. Cables use flexible vinyl or polyester that flexes as cables are bent.

## 3.7 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Visually inspect UTP and optical fiber jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA/EIA-568-B.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Test UTP copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.

    a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

4. Optical Fiber Cable Tests:

    a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
    b. Link End-to-End Attenuation Tests:

        1) Horizontal and multimode backbone link measurements: Test at 850 or 1,300 nm in 1 direction according to TIA/EIA-526-14-A, Method B, One Reference Jumper.
        2) Attenuation test results for backbone links shall be less than 2.0 dB. Attenuation test results shall be less than that calculated according to equation in TIA/EIA-568-B.1.

D. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

E. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

F. End-to-end cabling will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

END OF SECTION 271300

# SECTION 271500 - COMMUNICATIONS HORIZONTAL CABLING

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 27.

### 1.2 SUMMARY

A. Section Includes:

1. Pathways.
2. UTP cabling.
3. 62.5/125 multi-mode, and single-mode optical fiber cabling.
4. Cable connecting hardware, patch panels, and cross-connects.
5. Telecommunications outlet/connectors.
6. Cabling system identification products.
7. Cable management system.

### 1.3 DEFINITIONS

A. Basket Cable Tray: A fabricated structure consisting of wire mesh bottom and side rails.

B. BICSI: Building Industry Consulting Service International.

C. Channel Cable Tray: A fabricated structure consisting of a one-piece, ventilated-bottom or solid-bottom channel.

D. Consolidation Point: A location for interconnection between horizontal cables extending from building pathways and horizontal cables extending into furniture pathways.

E. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

F. EMI: Electromagnetic interference.

G. IDC: Insulation displacement connector.

H. Ladder Cable Tray: A fabricated structure consisting of two longitudinal side rails connected by individual transverse members (rungs).

I. LAN: Local area network.

J. Outlet/Connectors: A connecting device in the work area on which horizontal cable or outlet cable terminates.

K. RCDD: Registered Communications Distribution Designer.

L. Solid-Bottom or Non-ventilated Cable Tray: A fabricated structure consisting of longitudinal side rails and a bottom without ventilation openings.

M. Trough or Ventilated Cable Tray: A fabricated structure consisting of longitudinal side rails and a bottom having openings for the passage of air.

N. UTP: Unshielded twisted pair.

## 1.4 HORIZONTAL CABLING DESCRIPTION

A. Horizontal cable and its connecting hardware provide the means of transporting signals between the telecommunications outlet/connector and the horizontal cross-connect located in the communications equipment room. This cabling and its connecting hardware are called "permanent link," a term that is used in the testing protocols.

1. TIA/EIA-568-C requires that a minimum of two (2) telecommunications outlet/connectors be installed for each work area.
2. Transition points or consolidation points are not allowed between the horizontal cross-connect and the telecommunications outlet/connector.
3. Bridged taps and splices shall not be installed in the horizontal cabling.
4. Splitters shall not be installed as part of the optical fiber cabling.

B. A work area is approximately one hundred (100) sq. ft. and includes the components that extend from the telecommunications outlet/connectors to the station equipment.

C. The maximum allowable horizontal cable length is two hundred ninety five (295) feet. This maximum allowable length does not include an allowance for patch cords at the workstation, and patch cords at the equipment room. System designer should plan for a combined cable length (horizontal cable length plus patch cord length) not to exceed three hundred twenty eight (328) feet.

## 1.5 PERFORMANCE REQUIREMENTS

A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA/EIA-568-C, when tested according to test procedures of this standard.

1.6 SUBMITTALS

A. Product Data: For each type of product specified in this section.

B. Shop Drawings:

1. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
2. Cabling administration drawings and printouts.
3. Wiring diagrams to show typical wiring schematics, including the following:

   a. Cross-connects.
   b. Patch panels.
   c. Patch cords.

4. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.
5. Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:

   a. Vertical and horizontal offsets and transitions.
   b. Clearances for access above and to side of cable trays.
   c. Vertical elevation of cable trays above the floor or bottom of ceiling structure.
   d. Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.

6. Provide layout drawings coordinated with receptacle locations shown.
7. Provide test reports with corrective measures documented.

C. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector, and RCDD

D. Source quality-control reports.

E. Field quality-control reports.

F. Maintenance Data: For splices and connectors to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff. RCDD, testers, and installers shall be certified by the manufacturer of the product being installed.

1. Layout Responsibility: Preparation of Shop Drawings, Cabling Administration Drawings, and field testing program development by an RCDD.
2. Installation Supervision: Installation shall be under the direct supervision of RCDD, who shall be available at all times when Work of this Section is performed at Project site. A Level 2 Installer must be present at all times when Work of this Section is performed at Project site.
3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: Twenty five (25) or less.
2. Smoke-Developed Index: Four hundred fifty (450) or less.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Telecommunications Pathways and Spaces: Comply with TIA-569-B-2004.

E. Grounding: Comply with ANSI-J-STD-607-A-2002 and all applicable sections of NFPA 70, NEC.

## 1.8 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Test optical fiber cables while on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector; including the loss value of each. Retain test data and include the record in maintenance data.
2. Test each pair of UTP cable for open and short circuits.

## 1.9 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

B. Drywall, sanding, and all painting of all surfaces shall be completed before installing cable in equipment rooms.

1.10 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with UMB's telecommunications and LAN equipment and service suppliers.

B. Coordinate telecommunications outlet/connector locations with location of power receptacles at each work area, unless otherwise noted on telecommunications drawings to meet ADA requirements.

1.11 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Patch-Panel Units: One (1) of each type.
2. Connecting Blocks: One (1) of each type.

1.12 WARRANTY/GUARANTEE

A. See Division 26 Specification Section "Basic Electrical Requirements' for warranty and guarantee requirements.

**PART 2 - PRODUCTS**

2.1 PATHWAYS

A. General Requirements: Comply with TIA/EIA-569-B-2004.

B. Support of Open Cabling: NRTL labeled for support of Category 6 cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.

1. Velcro straps.
2. J-hooks.

C. Conduit and Boxes: Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems.

1. Outlet boxes shall be no smaller than two (2) inches wide, four (4) inches high and two and one half (2-1/2) inches deep.

2.2 UTP CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. Berk-Tek; a Nexans company.
2. CommScope, Inc.
3. Mohawk; a division of Belden CDT.
4. Superior Essex Inc.
5. General Cable Company.
6. Siemon

B. Description: 22-24 AWG, solid copper conductors, 100-ohm, 4-pair UTP, nominal impedance +/- 15%, green CMP Plenum jacket and complies with EIA/TIA 568-C Cat 6 standard.

1. Comply with ICEA S-90-661 for mechanical properties.
2. Comply with TIA/EIA-568-C, Category 6.
3. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:

a. Communications, Plenum Rated: Type CMP, complying with NFPA 262.

2.3 UTP CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. Siemon Co.
2. Ortronics Corp.

B. General Requirements for Cable Connecting Hardware: Comply with TIA/EIA-568-C, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of the same manufacturer and of same category or higher.

C. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.

1. Number of Terminals per Field: One (1) for each conductor in assigned cables.

D. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.

E. Number of Jacks per Field: One (1) for each two-pair conductor group of indicated cables, plus spares and blank positions adequate to suit specified expansion criteria.

F. Jacks and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.

G. Patch Cords: Factory-made, four-pair cables in thirty six (36) inch lengths terminated with eight-position modular plug at each end.

1. Patch cords shall have bend-relief-compliant boots to ensure Category 6 performance. Patch cords shall have latch guards to protect against snagging.

## 2.4 OPTICAL FIBER CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. Corning
2. SYSTIMAX Solutions; a CommScope, Inc. brand.
3. Optical Cable Corporation
4. Mohawk

B. Description: Multimode, 62.5/125-micrometer, 12-fiber, nonconductive, tight buffer, OM1, optical fiber cable. Single mode, 9/125-micrometer, 12-fiber, plenum-rated, optical fiber cable.

1. Comply with ICEA S-83-596 for mechanical properties.
2. Comply with TIA/EIA-568-C for performance specifications.
3. Comply with TIA/EIA-492AAAA-A for detailed specifications.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:

a. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.

5. Maximum Attenuation: 3.50dB/km at 850 nm; 1.0dB/km at 1300 nm for OM1 multimode, 1.0 dB/km at 1310 nm; 1.0 dB/km at 1550 nm for single mode.
6. Minimum Modal Bandwidth: 200 MHz-km at 850 nm; 500 MHz-km at 1300 nm for OM1 multimode.

C. Jacket:

1. Jacket Color: Orange for multimode and yellow for single mode.
2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA/EIA-598-C.
3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.

## 2.5 OPTICAL FIBER CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. Corning Cable Systems.

B. Cross-Connects and Patch Panels: Modular panels housing multiple-numbered, duplex cable connectors.

1. Number of Connectors per Field: One for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.

C. Patch Cords: Factory-made, dual-fiber cables in thirty six (36) inch lengths.

D. Cable Connecting Hardware:

1. Comply with Optical Fiber Connector Intermateability Standards (FOCIS) specifications of TIA/EIA-604-2, TIA/EIA-604-3-A, and TIA/EIA-604-12. Comply with TIA/EIA-568-C
2. Connectors: Quick-connect, duplex, Type SC, as manufactured for each cable type with insertion loss not more than 0. 5 dB.

## 2.6 TELECOMMUNICATIONS OUTLET/CONNECTORS

A. Jacks: 100-ohm, balanced, twisted-pair connector; four-pair, eight-position modular. Comply with TIA/EIA-568-C Cat 6.

B. Workstation Outlets: Four-port-connector assemblies mounted in single faceplate.

1. Metal Faceplate: Stainless steel, complying with requirements in Division 26 Section "Wiring Devices."
2. For use with snap-in jacks accommodating any combination of UTP, SC optical fiber, and work area patch cords.

a. Flush mounting jacks, positioning the cord (downward) at a 45-degree angle.
b. Flush mounting jacks, positioning the cord at a 90-degree angle for wall phones only.

3. Legend: Snap-in, clear-label covers and machine-printed paper inserts.

2.7 GROUNDING

A. Comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.

B. Comply with requirements of NFPA 70, NEC, National Electrical Code.

2.8 IDENTIFICATION PRODUCTS

A. Comply with TIA/EIA-606-A and UL 969 for labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

B. Comply with requirements in Division 26 Section "Identification for Electrical Systems."

2.9 SOURCE QUALITY CONTROL

A. Factory test UTP and optical fiber cables on reels according to TIA/EIA-568-C.

B. Factory test UTP cables according to TIA/EIA-568-C.

C. Factory test multimode and single mode optical fiber cables according to and TIA/EIA-568-C.

D. Cable will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports, including all deficiencies and corrective measures.

**PART 3 - EXECUTION**

3.1 WIRING METHODS

A. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters. Conceal raceway and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with requirements for raceways and boxes specified in Division 26 Section "Raceway and Boxes for Electrical Systems."

B. Wiring within Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools to comply with manufacturer’s recommendations.

## 3.2 INSTALLATION OF PATHWAYS

A. Cable Trays: Comply with NEMA VE 2 and TIA/EIA-569-B-2004.

B. Comply with requirements for demarcation point, pathways, cabinets, and racks specified in Division 27 Section "Communications Equipment Room Fittings." Drawings indicate general arrangement of pathways and fittings.

C. Comply with TIA/EIA-569-B-2004 for pull-box sizing and length of conduit and number of bends between pull points.

D. Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems" for installation of conduits and wireways.

E. Install manufactured conduit sweeps and long-radius elbows whenever possible.

F. Pathway Installation in Communications Equipment Rooms:

1. Position conduit ends adjacent to a corner on backboard where a single piece of plywood is installed, or in the corner of room where multiple sheets of plywood are installed around perimeter walls of room.
2. Install vertical and horizontal cable trays to route cables if conduits cannot be located in these positions.
3. Secure conduits to backboard when entering room from overhead.
4. Extend conduits three (3) inches above finished floor.
5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

G. Backboards: Install backboards with ninety six (96) inch dimension vertical. Butt adjacent sheets tightly, and form smooth gap-free corners and joints.

## 3.3 INSTALLATION OF CABLES

A. Comply with NECA 1-2010, The Standard Practice of Good Workmanship in Electrical Construction, and BICSI TDMM.

B. General Requirements for Cabling:

1. Comply with TIA/EIA-568-C.
2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
3. Install 110-style IDC termination hardware unless otherwise indicated. Terminate conductors; no cable shall contain un-terminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
4. Cables may not be spliced.

5. Secure and support cables at intervals not exceeding thirty (30) inches and not more than six (6) inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
6. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install distribution spools.
7. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Do not allow un-terminated cable to lay on floor, prior to installation. Remove and discard cable if damaged prior to and/or during installation and replace it in its entirety with new cable.
8. Cold-Weather Installation: Bring cable to room temperature before de-reeling. Heat lamps shall not be used for heating. In the communications equipment room, install a ten (10) foot long service loop in the cable tray, on the backboard or on each end of cable.
9. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions and ensure manufacturer's specified tension limits are not exceeded.

C. UTP Cable Installation:

1. Comply with TIA/EIA-568-C.
2. Do not untwist UTP cables more than one half (1/2) inch from the point of termination to maintain cable geometry.

D. Optical Fiber Cable Installation:

1. Comply with TIA/EIA-568-C.
2. Cable must be terminated on connecting hardware that is rack mounted.

E. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend UTP cable not in a wireway or pathway a minimum of eight (8) inches above ceilings by cable supports not more than forty eight (48) inches apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, equipment, or other potentially damaging items.

F. Conduit Installation:
1. Install conduit bushings at each end of conduit to avoid disturbing cable jacket. Provide pull string in spare conduits and label at both ends.

G. Installation of Cable Routed Exposed under Raised Floors:

1. Install plenum-rated cable only.
2. Install cabling after the flooring system has been installed in raised floor areas.

3. Coil cable six (6) feet long not less than twelve (12) inches in diameter below each feed point.

H. Group connecting hardware for cables into separate logical fields.

I. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA/EIA-569-B-2004 for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: A minimum of five (5) inches.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of twelve (12) inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of thirty six (36) inches.

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: A minimum of two and one half (2-1/2) inches.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of six (6) inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of eighteen (18) inches.

4. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
5. Separation between Communications Cables and Fluorescent Fixtures: A minimum of twelve (12) inches.

## 3.4 FIRESTOPPING

A. Comply with requirements in Division 07 Section "Penetration Firestopping."

B. Comply with TIA/EIA-569-B-2004, Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping Systems" Article.

## 3.5 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with ANSI-J-STD-607-A-2002.

C. Comply with NFPA 70-NEC.

D. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least two (2) inch clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG green THHN/THWN insulated grounding electrode conductor from grounding bus bar to suitable electrical building ground.

E. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG green THHN/THWN insulated equipment grounding conductor.

## 3.6 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

1. Administration Class: 3.

B. Comply with requirements in Division 09 Section "Interior Painting" for painting backboards.

C. Cable Schedule: Post in prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

D. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors. Follow convention of TIA/EIA-606-A. Furnish electronic record of all drawings, in software and format selected by Owner.

E. Cable and Wire Identification:

1. Label each cable within two (2) inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is required to be numbered at device and numbered within panel or cabinet.

3. Label each terminal strip and screw terminal in each outlet jack, cabinet, rack, and panel.

   a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with name and number of particular device as shown. Identify with one label.
   b. Label each unit and field within distribution racks and frames.
   c. Each outlet shall have an identification code consisting of five (5) digits (six (6) if "LL" is used instead of "B"). The first digit shall indicate the floor of the building where the outlet is located. The letter "G" shall be used for the ground floor. One (1) for the first floor, etc. The letter "B" shall be used for basements, "S" for subbasement, "LL" for lower level, and "M" for mezzanine.
   d. The second digit shall be the closet identifier. The letter "N" shall be used to indicate the north closet, the letter "S" shall be used to indicate the south closet, the letter "E" shall be used to indicate the east closet, and the letter "W" shall be used to indicate the west closet. If there is only one closet per floor, we use the letter "N."
   e. The last three digits shall denote the number of the outlet. Outlet numbers one (1) through nine (9) shall be preceded with two zeros (e.g. 1N008). Outlet number ten (10) through ninety nine (99) shall be preceded with one zero (e.g. 1N028).
   f. In the Telecommunications Room, data patch panels will be labeled with both the outlet # and the jack #. For instance for outlet # 1N028, the patch panel will read 1N028-D1, and 1N028-D2.
   g. The color code for Communication Outlet Icons is as follows:

      1) Category 6 data jack “GREEN”
      2) ‘SC’ Fiber jack “RED”

4. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware.

F. Labels shall be preprinted or computer-printed type with white printing area and black font color that complies with requirements in TIA/EIA-606-A.

   1. Labels on cables shall be flexible vinyl or polyester that flex as cables are bent.

## 3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Visually inspect UTP and optical fiber cable jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA/EIA-568-C.
2. Visually confirm Category 6 marking of outlets, cover plates, outlet/connectors, and patch panels.
3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
4. Test UTP horizontal copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination and before cross-connection.

    a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-C. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

5. Optical Fiber Cable Tests:

    a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-C. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
    b. Link End-to-End Attenuation Tests:

        1) Horizontal and multimode horizontal link measurements: Test at 850 or 1300 nm in one (1) direction according to TIA/EIA-526-14-A, Method B, One (1) Reference Jumper.
        2) Attenuation test results for horizontal links shall be less than 1.0 dB. Attenuation test results shall be less than that calculated according to equation in TIA/EIA-568-C.

6. UTP Performance Tests:

    a. Test for each outlet. Perform the following tests according to TIA/EIA-568-C:

        1) Wire map.
        2) Length (physical vs. electrical, and length requirements).
        3) Insertion loss.
        4) Near-end crosstalk (NEXT) loss.
        5) Power sum near-end crosstalk (PSNEXT) loss.
        6) Equal-level far-end crosstalk (ELFEXT).

7) Power sum equal-level far-end crosstalk (PSELFEXT).
8) Return loss.
9) Propagation delay.
10) Delay skew.

7. Optical Fiber Cable Performance Tests: Perform optical fiber end-to-end link tests according to TIA/EIA-568-C.
8. Final Verification Tests: Perform verification tests for UTP and optical fiber systems after the complete communications cabling and workstation outlet/connectors are installed.

   a. Voice Tests: These tests assume that dial tone service has been installed. Connect to the network interface device at the demarcation point. Go off-hook and listen and receive a dial tone. If a test number is available, make and receive a local, long distance, and digital subscription line telephone call.

C. Document data for each measurement. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

D. End-to-end cabling will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports noting all deficiencies and corrective measures

END OF SECTION 271500

# SECTION 280544 - SLEEVES AND SLEEVE SEALS FOR ELECTRONIC SAFETY AND SECURITY PATHWAYS AND CABLING

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this section and all other sections of Division 28.

### 1.2 SUMMARY

A. Section Includes:

1. Sleeves for pathway and cable penetration of non-fire-rated construction walls and floors.
2. Sleeve-seal systems.
3. Sleeve-seal fittings.
4. Grout.
5. Silicone sealants.

### 1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. LEED Submittals:

1. Product Data for Credit EQ 4.1: For sealants, documentation including printed statement of VOC content.

### 1.4 WARRANTY/GUARANTEE

A. See Division 26 Specification Section “Basic Electrical Requirements’ for warranty and guarantee requirements.

## PART 2 - PRODUCTS

### 2.1 SLEEVES

A. Wall Sleeves:

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

C. Sleeves for Rectangular Openings:

1. Material: Galvanized-steel sheet.
2. Minimum Metal Thickness:

a. For sleeve cross-section rectangle perimeter less than fifty (50) inches and with no side larger than sixteen (16) inches, thickness shall be 0.052 inch.
b. For sleeve cross-section rectangle perimeter fifty (50) inches or more and one or more sides larger than sixteen (16) inches, thickness shall be 0.138 inch.

### 2.2 SLEEVE-SEAL SYSTEMS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and pathway or cable.

1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

a. Advance Products & Systems, Inc.
b. CALPICO, Inc.
c. Metraflex Company (The).
d. Pipeline Seal and Insulator, Inc.
e. Proco Products, Inc.

2. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
3. Pressure Plates: Stainless steel.
4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.

1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

a. Presealed Systems.

2.4 GROUT

A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.

B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

C. Design Mix: 5,000-psi, twenty eight (28) day compressive strength.

D. Packaging: Premixed and factory packaged.

2.5 SILICONE SEALANTS

A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
2. Sealant shall have VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Silicone Foams: Multicomponent, silicone-based, liquid elastomers that, when mixed, expand and cure in place to produce a flexible, non shrinking foam.

**PART 3 - EXECUTION**

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Comply with NECA 1.

B. Comply with NEMA VE 2 for cable tray and cable penetrations.

C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:

1. Interior Penetrations of Non-Fire-Rated Walls and Floors:

a. Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants."
b. Seal space outside of sleeves with mortar, grout or silicone. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.

2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
3. Size pipe sleeves to provide one quarter (1/4) inch annular clear space between sleeve and pathway or cable unless sleeve seal is to be installed
4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
5. Install sleeves for floor penetrations. Extend sleeves installed in floors two (2) inches above finished floor level. Install sleeves during erection of floors.

D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:

1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.

E. Roof-Penetration Sleeves: Seal penetration of individual pathways and cables with flexible boot-type flashing units applied in coordination with roofing work to maintain any existing warranties

F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using PVC or steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for one (1) inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

G. Underground, Exterior-Wall and Floor Penetrations: Install PVC or steel pipe sleeves. Size sleeves to allow for one (1) inch annular clear space between pathway or cable and sleeve for installing sleeve-seal system.

## 3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at pathway entries into building.

B. Install type and number of sealing elements recommended by manufacturer for pathway or cable material and size. Position pathway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pathway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

## 3.3 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 280544

# SECTION 281300 - ACCESS CONTROL

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 28.

### 1.2 SUMMARY

A. Section Includes:
   1. Card readers and door hardware for integration into existing access control system.
   2. in a level of quality consistent with other specified items.

### 1.3 DEFINITIONS

A. CCTV: Closed-circuit television.

B. CPU: Central processing unit.

C. Credential: Data assigned to an entity and used to identify that entity.

D. dpi: Dots per inch.

E. DTS: Digital Termination Service. A microwave-based, line-of-sight communication provided directly to the end user.

F. GFI: Ground fault interrupter.

G. Identifier: A credential card; keypad personal identification number; or code, biometric characteristic, or other unique identification entered as data into the entry-control database for the purpose of identifying an individual. Where this term is presented with an initial capital letter, this definition applies.

H. I/O: Input/output.

I. LAN: Local area network.

J. Location: A Location on the network having a PC-to-controller communications link, with additional controllers at the Location connected to the PC-to-controller link with a

TIA 485-A communications loop. Where this term is presented with an initial capital letter, this definition applies.

K. PC: Personal computer. Applies to the central station, workstations, and file servers.

L. PCI Bus: Peripheral Component Interconnect. A peripheral bus providing a high-speed data path between the CPU and the peripheral devices such as a monitor, disk drive, or network.

M. PDF: Portable Document Format. The file format used by the Acrobat document-exchange-system software from Adobe.

N. PIB: Photo-Identification and Badging System.

O. RAS: Remote access services.

P. RF: Radio frequency.

Q. ROM: Read-only memory. ROM data are maintained through losses of power.

R. TCP/IP: Transport control protocol/Internet protocol incorporated into Microsoft Windows.

S. TWAIN: Technology without an Interesting Name. A programming interface that lets a graphics application, such as an image editing program or desktop publishing program, activate a scanner, frame grabber, or other image-capturing device.

T. UPS: Uninterruptible power supply.

U. USB: Universal serial bus.

V. WAN: Wide area network.

W. WAV: The digital audio format used in Microsoft Windows.

X. WMP: Windows media player.

Y. Wiegand: Patented magnetic principle that uses specially treated wires embedded in the credential card.

Z. Windows: Operating system by Microsoft Corporation.

AA. Workstation: A PC with software that is configured for specific, limited security-system functions.

BB. WYSIWYG: What You See Is What You Get. Text and graphics appear on the screen the same as they will in print.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Reference each product to a location on Drawings. Test and evaluation data presented in Product Data shall comply with SIA BIO-01.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Diagrams for cable management system.
2. System labeling schedules, including electronic copy of labeling schedules that are part of the cable and asset identification system of the software specified in Parts 2 and 3.
3. Wiring Diagrams. For power, signal, and control wiring. Show typical wiring schematics including the following:

a. Workstation outlets, jacks, and jack assemblies.
b. Patch cords.
c. Patch panels.

C. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Installing company must be on a pre-approved list furnished by the owner for installation services for this project.

B. Providers of manufactured components, installation, wiring and testing shall be the responsibility of a single contractor who is an authorized dealer for the product supplied and who has been continuously in business for a period of not less than five (5) years and is licensed as required by the jurisdictions where the work will occur to perform the work specified. The security contractor shall meet the following performance requirements:

C. Authorized Lenel dealer: The security firm shall be a Lenel dealer in good standing.

D. Technician Certification:

1. Technical personnel shall be certified by the factory for the installation and service of all Lenel components.

E. Security License Requirements: The security contractor and "all" personnel at the company (including technical and administrative staff) shall be licensed by the State of Maryland for a security license with the appropriate background checks. All employees will have a formal background check and go through a drug-testing program during their initial hire in your firm as a standard procedure.

F. Installer Qualifications: An employer of workers trained and approved by manufacturer.

1. Cable installer must have on staff a registered communication distribution designer certified by Building Industry Consulting Service International.

G. Source Limitations: Obtain all components through one source from single manufacturer.

H. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

I. Comply with NFPA 70, "National Electrical Code."

J. Comply with FCC - Part 15, "Radio Frequency Devices".

K. Comply with FCC - Part 68, "Communication of Terminal Equipment to the Telephone Network".

L. Comply with UL 294, "Access Control System Units".

M. Comply with UL 1076, "Proprietary Burglar Alarm Unit and Systems".

N. Comply with IEEE, "Institute of Electrical and Electronics Engineers".

O. Comply with Microsoft® Open Database Connectivity (ODBC) interface.

P. Comply with ISO Software Coding Standards for C++ and C##.

Q. Comply with RoHS, "Restriction of Hazardous Substances".

R. Comply with SIA DC-01 and SIA DC-03 and SIA DC-07.

## 1.6 SYSTEM DESCRIPTION

A. Adding card readers for access control into existing buildings with existing Lenel security system in place.

## 1.7 CONTRACTOR PERFORMANCE REQUIREMENTS

A. Working Hours Response: During normal working hours, all telephone calls placed to the contractor shall be answered by a live person, not an auto-attendant.

B. The contractor must be a certified dealer of all products utilized in the system to include: Lenel, American Dynamics, Aiphone, Code Blue, HID, Pelco

1.8 SUBSTITUTIONS AND QUALITY:

A. Where products are specified by name, provide and install that product. Substitutions will not be accepted for the access control or digital CCTV system or their sub-systems.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

B. Environmental Limitations: Do not deliver or install equipment until spaces are enclosed and weather tight, wet work in spaces is complete and dry, and work above ceilings is complete.

1.10 COMMISSIONING AND STARTUP

A. Program all newly installed field hardware into the existing system. All controllers, door interfaces, input and output panels should be entered and configured per operational guidelines provided by the hospital.

B. Follow all applicable business rules utilized in the existing system.

C. Supply training for personnel for data entry of cardholder information, badge printing and access level assignments. Contractor is not responsible for cardholder creation or badge production.

1.11 WARRANTY/GUARANTEE

A. See Division 26 Specification Section “Basic Electrical Requirements’ for warranty and guarantee requirements.

B. The system components shall be guaranteed against all defective materials, design and workmanship for a period of two (2) years from the date of acceptance by the client after final testing. New replacement parts shall be furnished promptly and defects in design and workmanship shall be corrected, without cost to the Owner, promptly upon receipt of notice from the Owner of failure of any part of the system during the guarantee period. This is a one year full parts and labor warranty and no alternative will be acceptable.

C. Any item failing before the one (1) year guarantee period expires shall be replaced and the guarantee extended for that item for twelve (12) months from the replacement date of the item.

D. The warranty period for any part which has a warranty by the manufacturer of longer than twelve (12) months shall be for the longer period. Provide a copy of the manufacturer's warranty period statement for all alarm equipment, all software, all major components, and other major devices.

## PART 2 - PRODUCTS

### 2.1 READER AND DOOR OPERATION

A. The card reader door, the system shall have the following operational capability:

1. Readers shall read cards while the door is in the open position.
2. Door shall lock automatically upon the door being opened.
3. Automatic locking of the door lock after the door has been opened can be delayed for a user-defined time period.
4. Alarm from the door shall be shunted following the presentation of a valid access card, activation of the request to exit device and/or the pressing of the exit button.
5. Shall include a separate (alternate) shunt timer to extend the door shunt time after an access granted access occurs when a valid card has been presented by an individual with special ADA requirements. This will be determined as a check box in that cardholder's card record, and will be user definable.
6. Each card reader door shall be monitored for both forced and propped open conditions. The system shall differentiate between the two types of conditions, and notify the alarm monitoring center of each specific alarm condition, initiating a different response for each alarm type.
7. All door locks for stairwells and exits shall have a master over-ride switch which will be placed at the Main Fire Control Panel location.
8. Inputs:

    a. Data from entry-control devices; use this input to change modes between access and secure.
    b. Database downloads and updates from the central station that include enrollment and privilege information.

9. Outputs:

    a. Indicate success or failure of attempts to use entry-control devices and make comparisons of presented information with stored identification information.
    b. Grant or deny entry by sending control signals to portal-control devices and mask intrusion-alarm annunciation from sensors stimulated by authorized entries.

c. Maintain a date-, time-, and Location-stamped record of each transaction and transmit transaction records to the central station.
d. Door Prop Alarm: If a portal is held open for longer than time listed in a schedule, alarm sounds.

10. With power supplies sufficient to power at voltage and frequency required for field devices and portal-control devices.
11. Data Line Problems: For periods of loss of communication with the central station, or when data transmission is degraded and generating continuous checksum errors, the controller shall continue to control entry by accepting identifying information, making authentication decisions, checking privileges, and controlling portal-control devices.

12. Controller Power: NFPA 70, Class II power-supply transformer, with 12- or 24-V ac secondary, backup battery and charger.
    a. Backup Battery: Valve-regulated, recombinant-sealed, lead-acid battery; spill proof. With single-stage, constant-voltage-current, limited battery charger, comply with battery manufacturer's written instructions for battery terminal voltage and charging current recommendations for maximum battery life.
    b. Backup Power-Supply Capacity: Four (4) hours of battery supply. Submit battery and charger calculations.
    c. Power Monitoring: Provide manual, dynamic battery-load test, initiated and monitored at the control center; with automatic disconnection of the controller when battery voltage drops below controller limits. Report by using local controller-mounted digital displays and by communicating status to central station. Indicate normal power on and battery charger on trickle charge. Indicate and report the following:

        1) Trouble Alarm: Normal power-off load assumed by battery.
        2) Trouble Alarm: Low battery.
        3) Alarm: Power off.

## 2.2 CARD READERS

A. Card-Reader Power: Powered from its associated controller, including its standby power source, and shall not dissipate more than 5 W.

B. Response Time: Card reader shall respond to passage requests by generating a signal that is sent to the controller. Response time shall be 800 ms or less, from the time the card reader finishes reading the credential card until a response signal is generated.

C. Enclosure: Suitable for surface, semi-flush, pedestal, or weatherproof mounting. Mounting types shall additionally be suitable for installation in the following locations:

1. Indoors, controlled environment.
2. Indoors, uncontrolled environment.
3. Outdoors, with built-in heaters or other cold-weather equipment to extend the operating temperature range as needed for operation at the site.

D. Display: Digital visual indicator shall provide visible and audible status indications and user prompts. Indicate power on or off, whether user passage requests have been accepted or rejected, and whether the door is locked or unlocked.

E. Touch-Plate and Proximity Readers:

1. The system shall use proximity readers manufactured by HID, and will use the "Thinline" series model of reader. Other manufacturers and product types are not acceptable.
2. The card reader shall read proximity cards in a range from direct contact to at least 6 inches from the reader.

F. Communication Protocol: Compatible with local processor.

G. Touch-Plate and Contactless Card Reader: The reader shall have "flash" download capability to accommodate card format changes. The card reader shall have capability of transmitting data to security control panel and shall comply with ISO/IEC 7816.

## 2.3 DOOR AND GATE HARDWARE INTERFACE

A. Exit Device with Alarm: Operation of the exit device shall generate an alarm and annunciate a local alarm. Exit device and alarm contacts are specified in Division 08 Section "Door Hardware."

1. Request to Exit Devices. Each card reader door will be equipped with a REX device manufactured by DSI. This will be a DSI 150I, and will enable the system to both differentiate and monitor the door for forced and prop open conditions.
2. Door Contacts. The status of each card reader door will be monitored with a magnetic door contact. This will be a Sentrol 1078C-W wide-gapped contact, no exceptions.

B. Exit Alarm: Operation of a monitored door shall generate an alarm. Exit devices and alarm contacts are specified in Division 08 Section "Door Hardware."

C. Electric Door Strikes: Use end-of-line resistors to provide power-line supervision. Signal switches shall transmit data to controller to indicate when the bolt is not engaged and the strike mechanism is unlocked, and they shall report a forced entry. Power and signal shall be from the controller. Electric strikes are specified in Division 08 Section "Door Hardware."

D. Electromagnetic Locks: End-of-line resistors shall provide power-line supervision. Lock status sensing signal shall positively indicate door is secure. Power and signal shall be from the controller. Electromagnetic locks are specified in Division 08 Section "Door Hardware."

## 2.4 CABLES

A. General Cable Requirements: Comply with requirements in Division 28 Section "Conductors and Cables for Electronic Safety and Security" and as recommended by system manufacturer for integration requirement.

B. PVC-Jacketed, TIA 232-F Cables:

1. Two pairs, No. 22 AWG, stranded (7x30) tinned copper conductors, polypropylene insulation, and individual aluminum-foil/polyester-tape shielded pairs with 100 percent shield coverage; PVC jacket.
2. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
3. NFPA 70, Type CM.
4. Flame Resistance: UL 1581 vertical tray.

C. PVC-Jacketed, TIA 485-A Cables: Two pairs, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors, PVC insulation, unshielded, PVC jacket, and NFPA 70, Type CMG.

D. Multiconductor, PVC, Reader and Wiegand Keypad Cables:

1. No. 22 AWG, paired and twisted multiple conductors, stranded (7x30) tinned copper conductors, semirigid PVC insulation, overall aluminum-foil/polyester-tape shield with 100 percent shield coverage, plus tinned copper braid shield with 65 % shield coverage, and PVC jacket.
2. NFPA 70, Type CMG.
3. Flame Resistance: UL 1581 vertical tray.
4. For TIA 232-F applications.

E. Paired, PVC, Reader and Wiegand Keypad Cables:

1. Three pairs, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors, polypropylene insulation, individual aluminum-foil/polyester-tape shielded pairs each with No. 22 AWG, stranded tinned copper drain wire, 100 % shield coverage, and PVC jacket.
2. NFPA 70, Type CM.
3. Flame Resistance: UL 1581 vertical tray.

F. Paired, Lock Cables:

1. One pair, twisted, No. 18 AWG, stranded (19x30) tinned copper conductors, PVC insulation, unshielded, and PVC jacket.
2. NFPA 70, Type CMG.
3. Flame Resistance: UL 1581 vertical tray.

G. Paired, Input Cables:

1. One pair, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors, polypropylene insulation, overall aluminum-foil/polyester-tape shield with No. 22 AWG, stranded (7x30) tinned copper drain wire, 100 % shield coverage, and PVC jacket.
2. NFPA 70, Type CMR.
3. Flame Resistance: UL 1666 riser flame test.

H. Paired, AC Transformer Cables:

1. One pair, twisted, No. 18 AWG, stranded (7x26) tinned copper conductors, PVC insulation, unshielded, and PVC jacket.
2. NFPA 70, Type CMG.

2.5 TRANSFORMERS

A. NFPA 70, Class II control transformers, NRTL listed. Transformers for security access-control system shall not be shared with any other system.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.

B. Examine roughing-in for LAN and control cable conduit systems to PCs, controllers, card readers, and other cable-connected devices to verify actual locations of conduit and back boxes before device installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Comply with recommendations in SIA CP-01.

B. Comply with TIA/EIA 606-A, "Administration Standard for Commercial Telecommunications Infrastructure."

## 3.3 CABLING

A. Comply with NECA 1, "Good Workmanship in Electrical Construction."

B. Wiring Method: Install wiring in raceway and cable tray except within consoles, cabinets, desks, and counters. Conceal raceway and wiring except in unfinished spaces.

C. Boxes and enclosures containing security-system components or cabling, and which are easily accessible to employees or to the public, shall be provided with a lock. Boxes above ceiling level in occupied areas of the building shall not be considered accessible. Junction boxes and small device enclosures below ceiling level and easily accessible to employees or the public shall be covered with a suitable cover plate and secured with tamperproof screws.

D. Install end-of-line resistors at the field device location and not at the controller or panel location.

## 3.4 CABLE APPLICATION

A. Comply with TIA 569-B, "Commercial Building Standard for Telecommunications Pathways and Spaces."

B. Cable application requirements are minimum requirements and shall be exceeded if recommended or required by manufacturer of system hardware.

C. TIA 232-F Cabling: Install at a maximum distance of fifty (50) feet.

D. TIA 485-A Cabling: Install at a maximum distance of four thousand (4,000) feet.

E. Card Readers and Keypads:

1. Install number of conductor pairs recommended by manufacturer for the functions specified.
2. Unless manufacturer recommends larger conductors, install No. 22 AWG wire if maximum distance from controller to the reader is two hundred fifty (250) feet, and install No. 20 AWG wire if maximum distance is five hundred (500) feet.
3. For greater distances, install "extender" or "repeater" modules recommended by manufacturer of the controller.
4. Install minimum No. 18 AWG shielded cable to readers and keypads that draw 50 mA or more.

F. Install minimum No. 16 AWG cable from controller to electrically powered locks. Do not exceed two hundred fifty (250) feet.

G. Install minimum No. 18 AWG ac power wire from transformer to controller, with a maximum distance of twenty five (25) feet.

## 3.5 GROUNDING

A. Comply with Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Comply with IEEE 1100, "Recommended Practice for Power and Grounding Electronic Equipment."

C. Ground cable shields, drain conductors, and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

D. Bond shields and drain conductors to ground at only one point in each circuit.

E. Signal Ground:

1. Terminal: Locate in each equipment room and wiring closet; isolate from power system and equipment grounding.
2. Bus: Mount on wall of main equipment room with standoff insulators.
3. Backbone Cable: Extend from signal ground bus to signal ground terminal in each equipment room and wiring closet.

## 3.6 INSTALLATION

A. Install card readers, keypads, push buttons, and biometric readers.

B. All electric locking and panic, and power transfer hardware will be supplied and installed by others. It is the security contractor’s responsibility to provide power and interface the security system to the electric hardware.

## 3.7 WIRING FIRESTOPPING

A. Comply with requirements in Division 07 Section "Firestopping."

B. Comply with TIA/EIA-569-A, Annex A, "Firestopping."

3.8 IDENTIFICATION

A. In addition to requirements in this article, comply with applicable requirements in Division 26 Section "Identification for Electrical Systems" and with TIA/EIA 606-A.

B. At completion, cable and asset management software shall reflect as-built conditions.

3.9 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:
   1. Operational Test: Verify card readers allow access for approved identification cards and reject access for non-approved cards. See Division 01 Section "Quality Requirements" for retesting and reinspecting requirements and Division 01 Section "Execution" for requirements for correcting the Work.

C. Devices and circuits will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION 281300

# SECTION 282300 - VIDEO SURVEILLANCE

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 28.

### 1.2 SUMMARY

A. Section includes a video surveillance system consisting of cameras, digital video recorder, data transmission wiring, and a control station with its associated equipment.

B. Video surveillance system shall be integrated with monitoring and control system specified in Section 281300 "Access Control," which specifies systems integration.

C. Work includes, but not limited to the following:

1. Install and integrate CCTV, and related security hardware.
2. Configure local access panels in various closets and the Server's computer system to communicate with one another.
3. Enter security system databases hardware configuration.
4. Test security system communication and operation in accordance with the specification.
5. Train operators and the system managers.
6. Provide cameras, power supplies for cameras, and other CCTV equipment including DVRs.

D. Bidding Requirements:

1. Submit complete detailed proposals with line item cost representation for components and associated installation labor. Lump sum bids will not be accepted.
2. Include as part of the bid response the following items:
3. Installation schedule with proposed manpower assignments,
4. Resumes for project manager and lead engineer for this project.
5. Review associated "E" and "TA" Series electrical, low voltage infrastructure drawings to verify that necessary conduit and floor boxes will be provided by others. The Owner will provide no additional infrastructure to support the Access Control Systems and Video Surveillance Systems. Any discrepancies with the identified infrastructure to support these systems should be questioned in the form

of a request for information (RFI) during the bidding process. Be responsible for any additional infrastructure requirements after receipt of contract for this project.

6. Unspecified Equipment and Material: Any item of equipment or material not specifically addressed on the drawings or in this document and required to provide complete and functional Access Control Systems and Video Surveillance Systems shall be provided in a level of quality consistent with other specified items.

E. Complete Engineering, installation, programming and maintenance of the security system for the North and South Switching Stations This system will consist of CCTV (Intellex) systems.

1.3 DEFINITIONS

A. AGC: Automatic gain control.

B. BNC: Bayonet Neill-Concelman - type of connector.

C. B/W: Black and white.

D. CCD: Charge-coupled device.

E. FTP: File transfer protocol.

F. IP: Internet protocol.

G. LAN: Local area network.

H. MPEG: Moving picture experts group.

I. NTSC: National Television System Committee.

J. PC: Personal computer.

K. PTZ: Pan-tilt-zoom.

L. RAID: Redundant array of independent disks.

M. TCP: Transmission control protocol - connects hosts on the Internet.

N. UPS: Uninterruptible power supply.

O. WAN: Wide area network.

1.4 PERFORMANCE REQUIREMENTS

A. Provide and install American Dynamics zoom, tilt and pan controllers for all of the cameras capable of such functions or approved equal.

B. Provide as shown on drawings quantity of Intellex DVR units, cameras, mounts, and controls.

C. Also, provide and install equipment vertical racks as required to hold the DVRs and other equipment.

D. All programming of all systems hardware is by the security contractor. A two year full parts and labor warranty is specified. Note that the full one year parts and labor warranty is unconditional and covers all portions of this system from failure, except for acts of God or misuse by the owner. During this one-year period, the security contractor must meet the following performance requirements:

1. Respond Onsite Within Two (2) Hours to Four (4) Hours
2. Advanced Loaners
3. Computerized Dispatch
4. Service technicians certified on Lenel systems and products.
5. Available seven (7) days a week, twenty four (24) hours a day.

E. Four hours of battery back-up is required on all access control panels.

1.5 CONTRACTOR PERFORMANCE REQUIREMENTS

A. Technical Personnel: The contractor shall have adequate technical staff located within thirty (30) miles of the university. At minimum, the contractor shall have at least twenty five (25) employees that are locally based in the Baltimore-Washington corridor.

B. Working Hours Response: During normal working hours, all telephone calls placed to the contractor shall be answered by a live person, not an auto-attendant.

C. Service Dispatch: The contractor shall use a computerized service dispatch system that is a commercial off-the-shelf product used for dispatching service companies. At the end of every week, the contractor will be required to email the hospital a list of all service calls and their status on an automatic basis. Excel spreadsheets are not acceptable for a service dispatch program.

D. The contractor shall have a dedicated position specifically for managing and dispatching service calls for their clients. This position shall perform no other functions except service-related dispatch functions and services.

E. Engineering: The contractor must have field-trained engineers on staff that are 100% conversant in AutoCAD and are able to provide the necessary electronic drawings and

submittals required for a project of this size. The engineer must also be certified at the Master level in Lenel.

F. Contractor must meet all security clearance requirements to meet NBHPP CHEMPAK standards.

G. The contractor must be a certified dealer of all products utilized in the system to include: Lenel, American Dynamics, Aiphone, Code Blue, HID, Pelco.

## 1.6 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include dimensions and data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For video surveillance. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Functional Block Diagram: Show single-line interconnections between components for signal transmission and control. Show cable types and sizes.
3. Dimensioned plan and elevations of equipment racks, control panels, and consoles. Show access and workspace requirements.
4. UPS: Sizing calculations.
5. Wiring Diagrams: For power, signal, and control wiring.

C. Equipment List: Include every piece of equipment by model number, manufacturer, serial number, location, and date of original installation. Add pretesting record of each piece of equipment, listing name of person testing, date of test, set points of adjustments, name and description of the view of preset positions, description of alarms, and description of unit output responses to an alarm.

## 1.7 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For video surveillance, cameras, camera-supporting equipment, accessories, and components, from manufacturer.

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.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Field quality-control reports.

C. Warranty: Sample of special warranty.

## 1.8 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For cameras, power supplies, infrared illuminators, monitors, videotape recorders, digital video recorders, video switches, and control-station components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Lists of spare parts and replacement components recommended to be stored at the site for ready access.

## 1.9 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NECA 1, Standard Practices for Good Workmanship in Electrical Construction.

C. Comply with NFPA 70, National Electrical Code.

D. FCC – Part 68, Connection of Terminal Equipment to the Telephone Network.

E. IEEE, Institution of Electrical and Electronics Engineers.

F. Microsoft® Open Database Connectivity (ODBC) interface

G. ISO Software Coding Standards for C++ and C##

H. RoHS, Reduction of Hazardous Substances.

I. EIA/TIA-170A, Electrical Performance Standard for Color Television.

J. Electronic data exchange between video surveillance system with an access-control system shall comply with SIA TVAC.

K. Where products are specified by name, provide and install that product. Substitutions will not be accepted for the access control or digital CCTV system or their sub-systems.

1.10 PROJECT CONDITIONS

A. Environmental Conditions: Capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

1. Control Station: Rated for continuous operation in ambient temperatures of $60^0$F to $85^0$F and a relative humidity of 20% to 80%, non-condensing.
2. Interior, Controlled Environment: System components, except central-station control unit, installed in temperature-controlled interior environments shall be rated for continuous operation in ambient temperatures of $36^0$F to $122^0$F dry bulb and 20% to 90% relative humidity, non-condensing. Use NEMA 250, Type 1 enclosures.
3. Interior, Uncontrolled Environment: System components installed in non-temperature-controlled interior environments shall be rated for continuous operation in ambient temperatures of $0^0$F to $122^0$F dry bulb and 20% to 90% relative humidity, non-condensing. Use NEMA 250, Type 12 enclosures.
4. Exterior Environment: System components installed in locations exposed to weather shall be rated for continuous operation in ambient temperatures of - $30^0$F to +$122^0$F dry bulb and 20% to 90% relative humidity, condensing. Rate for continuous operation when exposed to rain as specified in NEMA 250, winds up to eighty five (85) mph and snow cover up to twenty four (24) inches thick. Use NEMA 250, Type 4X enclosures.
5. Hazardous Environment: System components located in areas where fire or explosion hazards may exist because of flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers shall be rated, listed, and installed according to NFPA 70.
6. Corrosive Environment: System components subject to corrosive fumes, vapors, and wind-driven salt spray in coastal zones. Use NEMA 250, Type 4X enclosures.
7. Security Environment: Camera housing for use in high-risk areas where surveillance equipment may be subject to physical violence.

1.11 WARRANTY/GUARANTEE

A. See Division 26 Specification Section “Basic Electrical Requirements’ for warranty and guarantee requirements.

B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of cameras, equipment related to camera operation, and control-station equipment that fail in materials or workmanship within specified warranty period.

1. During the first year, provide a full service warranty program that guarantees a two to four hour on-site response, include all parts and labor, and provides advance replacements for any defective components. The installation contractor must qualify as the service organization and provide the on-site warranty service.

2. The system components shall be guaranteed against all defective materials, design and workmanship for a period of two-year from the date of acceptance by the client after final testing. New replacement parts shall be furnished promptly and defects in design and workmanship shall be corrected, without cost to the Owner, promptly upon receipt of notice from the Owner of failure of any part of the system during the guarantee period. This is a one year full parts and labor warranty and no alternative will be acceptable.
3. Any item failing before the one year guarantee period expires shall be replaced and the guarantee extended for that item for twelve months from the replacement date of the item.
4. The warranty period for any part which has a warranty by the manufacturer of longer than twelve (12) months shall be for the longer period. Provide a copy of the manufacturer's warranty period statement for all alarm equipment, all software, all major CCTV components, and other major devices.

## PART 2 - PRODUCTS

### 2.1 SYSTEM REQUIREMENTS

A. Video-signal format shall comply with NTSC standard, composite interlaced video. Composite video-signal termination shall be 75 ohms.

B. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor's entry connection to components.

C. Tamper Protection: Tamper switches on enclosures, control units, pull boxes, junction boxes, cabinets, and other system components shall initiate a tamper-alarm signal when unit is opened or partially disassembled. Control-station, control-unit alarm display shall identify tamper alarms and indicate locations.

### 2.2 STANDARD CAMERAS

A. The indoor/outdoor integrated CCTV camera and enclosure shall consist of a tamper/impact resistant, in-ceiling mountable dome enclosure with integrated fixed camera and lens. The integrated camera and lens shall consist of a camera and lens module that is packaged separately for shipment and which shall allow the installation of the enclosure to precede installation of the camera and lens. The cameras shall be Pelco or approved equal.

B. The tamper/impact resistant dome enclosure shall meet or exceed the following design and performance specifications:

1. The enclosure shall be easy to install, requiring only standard tools.
2. The tamper/impact resistant dome enclosure shall have the following external dimensions: overall height, when installed, shall not exceed 2.6 inches, and enclosure diameter shall not exceed 5.5 inches.
3. The enclosure back box, when installed, shall not require more than 1.75 inches of space inside a wall or ceiling.
4. Tamper resistant, pin-in-hex screws and tightening tool shall be provided to secure the cover assembly to the enclosure body.
5. The dome shall consist of 3.75-inch diameter, .125-inch thick polycarbonate high security bubble that has high optical clarity and nominal distortion at all camera angles.
6. The bubble shall be puncture-proof, capable of withstanding pointed impact forces of 35 foot-pounds without creating an internal depression greater than 0.2 inches.
7. The bubble shall be impact resistant, capable of withstanding repeated multiple blunt impact forces up to one hundred (100) foot-pounds.
8. The dome shall be available in clear or smoked versions. The smoked version shall have a maximum light loss not greater than 1.5 f-stops.
9. The enclosure shall be NEMA 4 and IP 66 rated, when installed.
10. The enclosure shall be suitable for use in environmental air handling spaces.
11. The enclosure, when loaded with camera and integrated low temperature resistor array, shall be capable of operation down to $-50^0$F.
12. The enclosure, when loaded with camera and integrated low temperature resistor array, shall be capable of de-icing the viewing surface of the enclosure down to $-10^0$F.
13. The enclosure shall be provided with an adapter plate for mounting to a standard 4S or double-gang electrical box or which can be used as a backing flange when mounting to a drop ceiling.
14. A clearly labeled pigtail shall be provided for connecting 12 VDC or 24 VAC power.
15. A male pigtail BNC connector shall be provided for connecting video.
16. The enclosure, when loaded with camera and integrated low temperature resistor array, at temperatures above $35^0$F, shall consume less than 2 watts of power.
17. The enclosure, when loaded with camera and integrated low temperature resistor array, at temperatures under $35^0$F, shall consume no more than 13 watts of power.
18. The enclosure, when installed, shall have no exposed cables.

C. The integrated camera and lens assembly shall consist of a charge-coupled device (CCD) camera with fixed focal length or varifocal lens that is mounted as an easily installable/removable module.

1. The CCD camera shall consist of either a one quarter (1/4) inch or one third (1/3) inch format interline transfer imager meeting NTSC (EIA) or PAL (CCIR) signal format specifications.

2. The cameras shall be available in either standard resolution monochrome capable of 420 TV lines of horizontal resolution, standard resolution color capable of 350 TV lines of horizontal resolution, or high resolution color capable of 470 lines of horizontal resolution.
3. The fixed focal length lenses available shall be 2.9mm, 6mm, 8mm, or 12mm. All cameras with fixed focal length lenses shall utilize one third (1/3) inch CCD imagers.
4. The high resolution color camera shall be available with a 2.6mm to 5.6mm varifocal length lens with on/off DIP switch for auto iris capability. This camera shall utilize a ¼-inch CCD imager.
5. All cameras, including the one quarter (1/4) inch CCD with varifocal lens, shall be capable of electronic light control, commonly referred to as electronic shutter.
6. All color cameras shall be 2:1 interlace and capable of AC line lock that is adjustable via potentiometer on the camera board.
7. A jumper shall be provided on the power supply board for configuring to either 12 VDC or 24 VAC power.
8. All cameras shall be protected from incorrect placement of the 12 VDC/24 VAC jumper.

D. The camera module shall meet or exceed the following design and performance specifications:

1. The camera module shall have two spring steel, compressible arms that create an interference fit that holds the module in place.
2. During installation and camera adjustment, the module design shall allow adjustment of the camera on three axes to allow maximum flexibility during scene adjustment.
3. The three axes shall be pan, tilt, and rotation.
4. The camera and lens, when installed on a ceiling or horizontal surface, shall be capable of 360 degrees of pan and no less than 70 degree of tilt. When field of view is factored, apparent tilt shall be no less than 90 degree.
5. The camera and lens, when installed on a wall or vertical surface, shall be capable of 180 degrees of pan and no less than 140 degree of tilt.
6. The camera module shall consist of the camera, lens, low temperature array, and 24 VAC power supply board.
7. The camera module shall be easy to install by being provided with a quick connect/disconnect connector.
8. The removable camera module shall allow unrestricted access to the inside of the enclosure during installation of the enclosure.

E. The indoor/outdoor integrated CCTV camera and in-ceiling mountable dome enclosure shall be provided with a manufacturer's warranty covering repair or replacement of defective parts for a period of two years from the date of shipment.

F. The indoor/outdoor integrated CCTV camera and in-ceiling mountable dome enclosure shall be the Pelco ICS150 Series Camclosure or approved equal.

## 2.3 POWER SUPPLIES

A. Low-voltage power supplies matched for voltage and current requirements of cameras and accessories, and of type as recommended by manufacturer.

B. All cameras will be powered by a central power supply and rack mounted. It shall be an Altronix R2416300ULCB or approved equal.

C. Power reader and alarm controllers from power provided. All power shall be hard-wired into the access control panels and power supplies. Plug-in receptacles are not acceptable.

D. The system data gathering panel control units shall be capable of operation for a period of no less than 4 hours with its standby battery system.

E. Power Supplies: Transformers and power supplies shall be provided for detectors, panels, and accessories. Power supplies shall meet or exceed the manufacturer's recommendations for individual devices served and shall be rated at 150% of the peak load as though all circuits are connected to motion detectors.

F. Battery Back-up: Stand-by batteries with charger shall power microprocessor-based units, controllers, and control panels and detectors in the event of a primary power failure. Batteries shall be sized to provide 150% capacity for four hours. An alarm shall be initiated upon failure of battery and/ or primary power.

G. Protect all equipment from surges and noise Provide grounding as per the manufacturer's requirements for the system provided or for the components used.

H. Lock power supply interface to fire control system to be provided and installed by others

## 2.4 CAMERA-SUPPORTING EQUIPMENT

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:
   1. Pelco.
   2. Or approved equal.

B. Pan Units: Motorized automatic-scanning units arranged to provide remote-controlled manual and automatic camera panning action, and equipped with matching mounting brackets.

   1. Scanning Operation: Silent, smooth, and positive.
   2. Stops: Adjustable without disassembly, to limit the scanning arc.

C. Pan-and-Tilt Units: Motorized units arranged to provide remote-controlled aiming of cameras with smooth and silent operation, and equipped with matching mounting brackets.

1. Panning Rotation: 0 to 355 degrees, with adjustable stops.
2. Tilt Movement: 90 degrees, plus or minus 5 degrees, with adjustable stops.
3. Speed: 12 degrees per second in both horizontal and vertical planes.
4. Wiring: Factory prewired for camera and zoom lens functions and pan-and-tilt power and control.
5. Built-in encoders or potentiometers for position feedback.
6. Pan-and-tilt unit shall be available with preset positioning capability to recall the position of a specific scene.

D. Mounting Brackets for Fixed Cameras: Type matched to items supported and mounting conditions. Include manual pan-and-tilt adjustment.

## 2.5 SIGNAL TRANSMISSION COMPONENTS

A. Cable: Coaxial cable elements have 75-ohm nominal impedance. Comply with requirements in Section 280513 "Conductors and Cables for Electronic Safety and Security."

B. Video Surveillance Coaxial Cable Connectors: BNC type, 75 ohms. Comply with requirements in Section 280513 "Conductors and Cables for Electronic Safety and Security."

# PART 3 - EXECUTION

## 3.1 COORDINATION

A. Coordinate layout and installation of Video Surveillance Systems equipment with Owner’s security representative.

1. Meet jointly with Owner to exchange information and agree on details of equipment arrangements and installation interfaces.
2. Record agreements reached in meetings and distribute them to other participants.

B. Coordinate layout and installation of the Video Surveillance Systems cable pathways with telecommunications contractor.

## 3.2 EXAMINATION

A. Examine pathway elements intended for cables. Check raceways and other elements for compliance with space allocations, installation tolerance, hazards to camera installation, and other conditions affecting installation.

B. Examine roughing-in for LAN, WAN, and IP network before device installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.3 WIRING

A. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems."

B. Wiring Method: Install cables in raceways unless otherwise indicated.

1. Conceal raceways and wiring except in unfinished spaces.

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

D. Splices, Taps, and Terminations: For power and control wiring, use numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

E. For LAN connection and fiber-optic and copper communication wiring, comply with Section 271300 "Communications Backbone Cabling" and Section 271500 "Communications Horizontal Cabling."

F. Grounding: Provide independent-signal circuit grounding recommended in writing by manufacturer.

## 3.4 VIDEO SURVEILLANCE SYSTEM INSTALLATION

A. Install cameras and infrared illuminators level and plumb.

B. Install cameras with eighty four (84) inch minimum clear space below cameras and their mountings. Change type of mounting to achieve required clearance.

C. Set pan unit and pan-and-tilt unit stops to suit final camera position and to obtain the field of view required for camera. Connect all controls and alarms, and adjust.

D. Install power supplies and other auxiliary components at control stations unless otherwise indicated.

E. Install tamper switches on components indicated to receive tamper switches, arranged to detect unauthorized entry into system-component enclosures and mounted in self-protected, inconspicuous positions.

F. Avoid ground loops by making ground connections only at the control station.

1. For 12- and 24-V dc cameras, connect the coaxial cable shields only at the monitor end.

G. Identify system components, wiring, cabling, and terminals according to Section 260553 "Identification for Electrical Systems."

## 3.5 SERVICE AND MAINTENANCE

A. Owner's security personnel in operation and management operations, including changing signal pathways for different workstations, rerouting signals in failed cables, and keeping records of access assignments and revisions when extending elements to establish new access outlets.

B. General Requirements: Provide all services required and equipment necessary to maintain the entire SMS in an operational state as specified for a period of two (2) year(s) after formal written acceptance of the system, and shall provide all necessary material required for performing scheduled service or other unscheduled work.

C. Description of Work: The service and repair of the SMS including all equipment provided under this specification supplied by the successful contractor. Provide the manufacturer's required scheduled and unscheduled maintenance and all other work necessary to keep the SMS at its maximum performance.

D. Personnel: Service personnel shall be factory certified in the maintenance and repair of the equipment installed under this section of the specification. The owner shall be advised in writing of the name of the designated service representative, and of any change in personnel.

E. Schedule of Work: This work shall be performed during regular working hours (8-5), Monday through Friday, excluding federal holidays.

1. Inspections: The Contractor shall perform two (2) minor inspections at six (6) month intervals (or more often if required by the manufacturer), and two (2) major inspections offset equally between the minor inspections to effect quarterly inspection of alternating magnitude.
2. Minor Inspections: These inspections shall include:

a. Visual checks and operational tests of all console equipment, peripheral equipment, field hardware, sensors, and electrical and mechanical controls.
b. Mechanical adjustments if required on any mechanical or electromechanical devices

3. Major Inspections: These inspections shall include all work described under paragraph Minor Inspections and the following work:

a. Clean all SMS equipment, including interior and exterior surfaces.
b. Perform diagnostics on all equipment.
c. Check, walk test, and if required by the manufacturer's maintenance procedures, calibrate each sensor.
d. Run all system software diagnostics and correct all diagnosed problems.

F. Operation: Performance of scheduled adjustments and repair shall verify operation of the SMS as demonstrated by the applicable tests of the performance verification test.

G. Emergency Service: The owner will initiate service calls when the SMS is not functioning properly and hinders critical operation of the facility. Qualified personnel shall be available to provide service to the complete SMS repairs. The owner shall be furnished with a telephone number where the service supervisor can be reached at all times. Service personnel shall be at site within four (4) hours after receiving a request for service. The SMS shall be restored to proper operating condition within eight (8) hours after service personnel arrive on site.

H. Records and Logs: Keep records and logs of each task, and shall organize cumulative records for each component, and for the complete system chronologically. A continuous log shall be maintained for all devices. The log shall contain all initial settings. Complete logs shall be kept and shall be available for inspection on site, demonstrating that planned and systematic adjustments and repairs have been accomplished for the SMS.

I. Work Requests: Separately record each service call request on a service request form. The form shall include the model and serial number identifying the component involved, its location, date and time the call was received, specific nature of trouble, names of service personnel assigned to the task, instructions describing what has to be done, the amount and nature of the materials used, the time and date work started, and the time and date of completion. Deliver a record of the work performed within five (5) days after work is accomplished.

J. System Modifications: Make any recommendations for system modification in writing to the Owner. No system modifications, shall be made without prior approval of the Owner. Any modifications made to the system shall be incorporated into the operations and maintenance manuals, and other documentation affected.

K. Software: Provide all software updates during the period of the warranty and verify operation in the system. These updates shall be accomplished in a timely manner, fully coordinated with SMS operators, shall include training for the new changes/features enabled, and shall be incorporated into the operations and maintenance manuals, and software documentation.

## 3.6 DEVICE WIRING AND COMMUNICATION CIRCUIT SURGE PROTECTION

A. All inputs shall be protected against surges induced on device wiring. Outputs shall be protected against surges induced on control and device wiring installed outdoors and as shown. All communications equipment shall be protected against surges induced on any communications circuit. All cables and conductors, except fiber optics, which serve as communications circuits from security console to field equipment, and between field equipment, shall have surge protection circuits installed at each end.

## 3.7 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

D. Tests and Inspections:

1. Inspection: Verify that units and controls are properly installed, connected, and labeled, and that interconnecting wires and terminals are identified.
2. Pretesting: Align and adjust system and pretest components, wiring, and functions to verify that they comply with specified requirements. Conduct tests at varying lighting levels, including day and night scenes as applicable. Prepare video-surveillance equipment for acceptance and operational testing as follows:

    a. Prepare equipment list described in "Informational Submittals" Article.
    b. Verify operation of auto-iris lenses.
    c. Set back-focus of fixed focal length lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Adjust until image is in focus with and without the filter.

d. Set back-focus of zoom lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Additionally, set zoom to full wide angle and aim camera at an object fifty (50) to seventy five (75) feet away. Adjust until image is in focus from full wide angle to full telephoto, with the filter in place.
e. Set and name all preset positions; consult Owner's personnel.
f. Set sensitivity of motion detection.
g. Connect and verify responses to alarms.
h. Verify operation of control-station equipment.

3. Test Schedule: Schedule tests after pretesting has been successfully completed and system has been in normal functional operation for at least fourteen (14) days. Provide a minimum of ten (10) days' notice of test schedule.
4. Operational Tests: Perform operational system tests to verify that system complies with Specifications. Include all modes of system operation. Test equipment for proper operation in all functional modes.

E. Video surveillance system will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

## 3.8 ADJUSTING

A. Occupancy Adjustments: When requested within twelve (12) months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two (2) visits to Project during other-than-normal occupancy hours for this purpose. Tasks shall include, but are not limited to, the following:

1. Check cable connections.
2. Check proper operation of cameras and lenses. Verify operation of auto-iris lenses and adjust back-focus as needed.
3. Adjust all preset positions; consult Owner's personnel.
4. Recommend changes to cameras, lenses, and associated equipment to improve Owner's use of video surveillance system.
5. Provide a written report of adjustments and recommendations.

## 3.9 CLEANING

A. Clean installed items using methods and materials recommended in writing by manufacturer.

B. Clean video-surveillance-system components, including camera-housing windows, lenses, and monitor screens.

3.10 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain video-surveillance equipment.

END OF SECTION 282300

# SECTION 283111 - DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 28.

### 1.2 SUMMARY

A. Section Includes:

1. Fire alarm systems with manual stations, detectors, signal equipment, controls, digital amplifiers, booster panels, digital voice communication and devices.
2. Connection to door hardware for door closers/holders, electric door locks, and release existing devices that interface with fire alarm systems.
3. Contractor shall provide and install microprocessor based fire alarm and detection system devices in accordance with NFPA 72. The system components shall be the product of Notifier. Installation shall include all parts, labor, software, and hardware necessary to effect a complete installation.
4. Connection to existing building fire alarm system.
5. Provide Class A Loop Multi-Mode fiber optic cable for fire alarm network system in new/existing duct bank to buildings. Installation shall comply with NFPA 72 and NFPA 70.

B. Section Includes:

1. Fire-alarm control unit.
2. Manual fire-alarm boxes.
3. System smoke detectors.
4. Heat detectors.
5. Notification appliances.
6. Magnetic door holders.
7. Remote graphic annunciator Panel.
8. Addressable interface device.
9. Digital alarm communicator transmitter.
10. System printer.
11. Duct smoke detectors.
12. Emergency telephone stations.
13. Remote transponder panel.
14. Emergency power supply.

15. Manual Emergency exit pull stations.
16. Control relays and contact input modules.
17. Line isolation modules.
18. Knox Box.
19. Beam Detectors.
20. Interface to existing Campus Central Network Stations.

## 1.3 SYSTEM DESCRIPTION

A. Non-coded, UL-certified addressable system, with multiplexed signal transmission, dedicated to fire-alarm service only.

B. Non-coded addressable system, with automatic sensitivity control of certain smoke detectors and multiplexed signal transmission, dedicated to fire-alarm service only.

C. System shall be capable of full monitoring, control and remote control through UMB Campus Central Network Stations. System to have voice audible capability and shall be connected to UMB Mass Notification System.

D. Mass Notification System (MNS) shall be designed and installed per NFPA 72. System shall meet the requirements of one-way emergency communications systems with in-building MNS capabilities.

E. Presently, UMB has a contract to upgrade the existing buildings FACP and Network Command Centers with the latest version of Software/Firmware. Under this project, the contractor shall coordinate with the UMB Project Manager for the programming of the building panel and the correct version of Software/Firmware must be provided prior to programming.

F. General:

1. The existing fire alarm control panel for Howard Hall is a Notifier NFS2-3030 with DVC Voice Command Unit. Bidders will be responsible for supplying all components to complete a fully functional Emergency Voice Evacuation in accordance with the project specifications and drawings. Each day, the contractor and sub-contractors shall sign-in and sign-out the fire alarm system at the Campus Police Station located at 214 Pine Street, Baltimore, MD.

G. Prior to programming the fire alarm system at all buildings, the contractor shall contact UMB Project Manager to obtain available nodes.

H. Initiating Devices: Provide initiating devices for each application throughout as required by NFPA 72.

I. Notification Appliances:

1. Provide combination speaker/strobe signals throughout as required to ensure audibility and intelligibility of signal as detailed in NFPA 72.
2. Provide any additional notification appliances as required by the ADA.
3. Fire alarm notification appliances shall remain active until the fire alarm system is manually silenced or acknowledged.
4. Both audible and visible notification appliances shall be simultaneously de-activated.

J. Auxiliary Functions:

1. Door Holders – Release doors automatically upon activation of associated smoke detector(s).
2. Smoke Dampers – Close respective smoke damper upon activation of associated duct smoke detector(s).
3. Provide 3rd party interface connections to building security system, halon system etc. as required.

K. Voice/Alarm:

1. During normal system operation, activation of any alarm initiating device shall cause an attention signal to be broadcast over audible signals to be followed by a custom voice message.

L. There are three (3) NFN Network Stations installed on the campus. Provide all new work associated with connections, programming and modifications to the existing NFN Network Stations under this project.

## 1.4 SUBMITTALS

A. General Submittal Requirements: Comply with the UMB General Conditions.

1. Prior to submission to UMB Fire Marshal, submittal must be reviewed by the Engineer of Record.
2. Shop Drawings shall be prepared by persons trained and certified by the manufacturer in fire-alarm system design. Shop drawings shall be signed or stamped by an individual with one of the following qualifications:

a. NICET fire-alarm technician, Level IV minimum.
b. Professional Engineer registered in the State of Maryland.

B. Product Data: For each type of product indicated.

C. Shop Drawings: For fire-alarm system. Include plans, elevations, sections, details, and attachments to other work.

1. Comply with NFPA 72 "Documentation" chapter.

2. Include voltage drop calculations for notification appliance circuits.
3. Include battery-size calculations.
4. Load Calculations - Provide load calculations for all NAC circuits while noting both current demand and future capacity in amperes.
5. Device Address List: Coordinate with final system programming. Floor plans shall include address numbers for all devices.
6. System Sequence of Operation: Detailed description for this Project, including method of operation and supervision of each type of circuit and sequence of operations for manually and automatically initiated system inputs and outputs. Manufacturer's standard descriptions for generic systems are not acceptable.
7. Details of graphic and alphanumeric annunciators.
8. Include performance parameters and installation details for each detector, verifying that each detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
9. Include half-size plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale and coordinating installation of duct smoke detectors and access to them. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators. Locate detectors according to manufacturer's written recommendations.
10. Include voice/alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.
11. Include List of extra materials to be provided for the project.
12. Provide one (1) printed set of drawings (preferably "half-size" fifteen (15) inches x twenty one (21) inches) and one (1) electronic file in pdf file format.
13. Shop Drawings must include the following:

    a. Provide floor plans with ALL device locations and their associated addresses. Floor plans must be drawn to scale.
    b. For new building construction projects or replacement of existing building entire fire alarm system projects, use NFPA 170 symbols.
    c. For renovation projects match the symbols used on As-Builts.
    d. Provide a riser diagram, regardless of system size.
    e. Wiring Diagrams: Provide the following:

        1) Detail wiring and differentiate between manufacturer-installed and field-installed wiring.
        2) Include diagrams for equipment and for system with all terminals and interconnections identified.
        3) Include all internal network cards and boards in FACP and Transponder Panels.

14. For projects involving only modifications to an existing FAS, the University will provide electronic copies to the FAS manufacturer of their latest version of the FAS As-Builts. The FAS manufacturer will make all necessary revisions to the

FAS as-builts and submit them for review/approval. Once the project is completed, the FAS manufacturer will update the copies for forwarding electronically to the University for archiving. In revising the electronic copies of the University's as-builts, please perform the changes in the following format:

a. Show all new wiring and equipment in bold so it is convenient to differentiate between new and existing.

D. Qualification Data: For qualified Installer.

E. Field quality-control reports.

F. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Comply with the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
2. Provide "Record of Completion Documents" according to NFPA 72 article "Permanent Records" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter.
3. Record copy of site-specific software.
4. Provide "Maintenance, Inspection and Testing Records" according to NFPA 72 article of the same name and include the following:

   a. Frequency of testing of installed components.
   b. Frequency of inspection of installed components.
   c. Requirements and recommendations related to results of maintenance.
   d. Manufacturer's user training manuals.

5. Manufacturer's required maintenance related to system warranty requirements.
6. Abbreviated operating instructions for mounting at fire-alarm control unit.

G. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On magnetic media or compact disk, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

H. Informational Submittals: Submit the following:

1. Operating Instructions: For mounting at FACP.
2. Product Certificates: Signed by manufacturers of system components certifying that products furnished comply with requirements.

3. Installer Certificates: Signed by manufacturer certifying that installers comply with requirements.
4. Field Test Reports: Indicate and interpret test results for compliance with performance requirements. Comply with NFPA 72.

I. Submissions to UMB Fire Marshal:
1. Include copies of annotated Contract Drawings as needed to depict component locations to facilitate review. Resubmit if required to make clarifications or revisions to obtain approval.

J. Project Closeout Submittals: Submit the following in accordance with the UMB General Conditions.

1. Electronic Copies of System Program: Provide a minimum of two (2) electronic copies of the system program on CD/DVD. Store one (1) CD/DVD copy of the program at the FACP and hand the other copy over to the Project Manager. Besides being required by NFPA 72, the purpose for this requirement is to ensure the owner always has on hand a "bug free" copy of the original.
2. Manufacturer's As-Built Drawings: Submit one (1) set of the Manufacturer's As-Built Drawings as a hard copy to UMB Fire Marshal for review prior to scheduling a Final Acceptance Test.

    a. As-Built Drawings: The FAS Manufacturer shall revise/update the FAS Shop Drawings to accurately reflect the following field installation data/conditions:

        1) All individual device addresses on the floor plans.
        2) Conduit/SLC & NAC Loop Wiring Layout - Show routing of all FAS wiring and raceway including riser runs and while noting all FAS device and panel locations. Identify all panels with their respective ID numbers/lettering as entered in the FAS programming software. Where multiple FAS circuits are run in parallel and/or grouped together, attach drawing notes to the runs to identify the individual FAS circuits in the grouped or parallel run. Delineate overhead versus underground runs by using dashed lines for underground.
        3) Riser and/or connection diagram.

    b. Equipment Data: Provide Manufacturer's catalog information on all internal network cards/option modules in the system.
    c. Provide both paper and electronic (both AutoCAD 2010 and PDF format) copies. Provide three (3) paper copies in "half-size" sets and two (2) paper copies at full size.

3. Updated copies of load calculations, System Program and Sequence of Operation as submitted during in the shop drawing phase.

4. Maintenance Data: For fire alarm systems. Comply with NFPA 72.
5. Record of Completion: Comply with NFPA 72.

## 1.5 QUALITY ASSURANCE

A. Installer Qualifications: The contractor supervising the installation must be a National Institute for Certification in Engineering Technologies (NICET) Level IV senior engineering technician. In addition, the installing contractor must be a certified installer of the fire alarm systems.

B. Installer must provide a list of five (5) previous projects done for the FAS manufacturer that are equivalent in FAS system type and scope of this project.

C. Manufacturer Qualifications: Firm experienced in manufacturing systems similar to those indicated for this Project and with record of successful in-service performance.

D. Source Limitations: Obtain fire alarm system components through one source from single manufacturer. Components shall be compatible with, and operate as, an extension of existing system.

E. Compliance with Local Requirements: Comply with applicable building code, local ordinances and regulations, and requirements of UMB Fire Marshal.

F. Comply with NFPA 70 and 72.

G. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

## 1.6 PROJECT CONDITIONS

A. Interruption of Existing Fire-Alarm Service: Do not interrupt fire-alarm service to facilities occupied by Owner or others unless permitted under the following conditions:

1. Notify UMB Project Manager no fewer than ten (10) days in advance of proposed interruption of fire-alarm service.
2. Do not proceed with fire-alarm outage without UMB Project Manager's written permission.
3. Where a required existing fire protection system is out of service or during system Outage, the contractor shall provide fire watch as required by the UMB Fire Marshal until the existing system is restored.
   http://www.umaryland.edu/media/umb/af/ehs/firesafety/FireWatchProcedures.pdf

## 1.7 SEQUENCING AND SCHEDULING

A. Existing Fire-Alarm Equipment: Maintain existing equipment fully operational until new equipment has been tested and accepted. As new equipment is installed, label it "NOT IN SERVICE" until it is accepted. Remove labels from new equipment when put into service and label existing fire-alarm equipment "NOT IN SERVICE" until removed from the building.

## 1.8 SOFTWARE SERVICE AGREEMENT

A. Comply with UL 864.

B. Technical Support: Beginning with Substantial Completion, provide software support for two years.

C. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two (2) years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.

1. Provide ten (10) days' notice to Owner to allow access to the system.

## 1.9 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Deliver materials to UMB Project Manager with Bill of Materials in accordance with UMB general conditions. Include list of extra materials with the shop drawing submittal. Where multiple buildings are being bid as one project, provide extra materials for each building.

1. Lamps for Remote Indicating Lamp Units: Quantity equal to 10% of amount installed, but no fewer than one (1) unit.
2. Smoke Detectors, Heat Detectors (each type), Fire Detectors, and Flame Detectors: Quantity equal to 10% of amount of each type installed, but no fewer than 1 unit of each type.
3. Detector Bases: Quantity equal to 2% of amount of each type installed, but no fewer than one (1) unit of each type.
4. Keys and Tools: One (1) extra set for access to locked and tamper proofed components.
5. Audible and Visual Notification Appliances: Two (2) of each type installed. Provide two (2) audio visual modules.
6. Fuses: Two (2) of each type installed in the system.
7. FMM-1, FDM-1, FRM-1, FCM-1, FMM-101 addressable modules. Provide quantity equal to 10% of amount installed, but not less than one (1) unit.

8. Printer Ribbons: Six (6) spares.
9. Appliance Audio Amplifiers: Provide two (2) spare audio amplifiers, DAA2 series amps. Provide two (2) spare back-up audio amplifiers, BDA-70 series amps.

1.10 WARRANTY/GUARENTEE

A. See Division 26, Specification Section "Basic Electrical Requirements" for warranty and guarantee requirements.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

A. Manufacturers:

1. New Fire Alarm System NOTIFIER:

a. Fire Alarm Control Panel Model NFS2-3030 with display.
b. Digital Voice Command (DVC), Voice Evacuation Control System.

B. Manufacturers:

1. Existing Fire Alarm System (Howard Hall) NOTIFIER**:**

a. Fire Alarm Control Panel Model NFS2-3030 with display.
b. Digital Voice Command (DVC), Voice Evacuation Control System.

2. Provide for the existing Howard Hall fire alarm system, as required and as indicated on the drawings:

a. Refer to Para, 2.2 and 2.3.
b. Modifications to wiring and connections.
c. Reprogramming of control panel, addresses, etc.
d. Additional parts, modules, amplifiers, relays, etc.
e. Connections to existing supervisory and alarm devices not being replaced with new.
f. Connections for auxiliary functions, as required.
g. Extensions of signal control and power wiring, as required. SLC and/or NAC 'T' taps are strictly prohibited on both SLC and NAC loops. If this poor workmanship is discovered, it will be required to be removed.
h. Connections to new and existing components.
i. The existing devices shall be upgraded with proper addressable modules, monitoring modules, relay modules etc. and any new devices shall be provided with new modules to ensure that the system is code compliant as required by the UMB Fire Marshal.

j. Provide 3rd party interface connections to security system, halon system etc.
k. Provide all new wiring.
l. Mass Notification System

## 2.2 SYSTEMS OPERATIONAL DESCRIPTION

A. Fire-alarm signal initiation shall be by one (1) or more of the following devices and systems:

1. Manual stations.
2. Heat detectors.
3. Smoke detectors.
4. Elevator Machine Room initiating devices.
5. Verified automatic alarm operation of smoke detectors.
6. Automatic sprinkler system water flow.
7. Fire standpipe system.
8. Fire Pump Running

B. Supervisory signal initiation shall be by one (1) or more of the following devices and actions:

1. Valve supervisory switch.
2. Low-air-pressure switch of a dry-pipe sprinkler system.
3. Elevator shunt-trip supervision.
4. Duct smoke detectors.

C. System trouble signal initiation shall be by one (1) or more of the following devices and actions:

1. Open circuits, shorts, and grounds in designated circuits.
2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
3. Loss of primary power at fire-alarm control unit.
4. Ground or a single break in fire-alarm control unit internal circuits.
5. Abnormal ac voltage at fire-alarm control unit.
6. Break in standby battery circuitry.
7. Failure of battery charging.
8. Abnormal position of any switch at fire-alarm control unit or annunciator.
9. Fire-pump power failure, including a dead-phase or phase-reversal condition.
10. Low-air-pressure switch operation on a dry-pipe or preaction sprinkler system.

D. System Trouble and Supervisory Signal Actions: Initiate and annunciate at fire-alarm control unit and remote annunciators. Record the event on system printer. Transmit trouble and supervisory signals to remote alarm receiving central network stations.

E. Control of System: By FACP and by Remote Transponder(s) as required on Contract Drawings.

F. System Supervision: Automatically detect and report open circuits, shorts, and grounds of wiring for initiating device, signaling line, and notification-appliance circuits.

G. Priority of Signals: Automatic alarm response functions resulting from alarm signal from one zone or device are not altered by subsequent alarm, supervisory, or trouble signals. Alarm signal is highest priority. Supervisory and trouble signals have second- and third-level priority. Higher-priority signals take precedence over signals of lower priority, even when lower-priority condition occurs first. Annunciate and display all alarm, supervisory, and trouble signals regardless of priority or order received. If a live mass notification message is sent from the Campus Police, the broadcasted message shall have priority over the recorded building voice message.

H. Noninterference: Signal on one zone shall not prevent receipt of signals from other zones.

I. System Reset: All zones are manually resettable from FACP after initiating devices are restored to normal.

J. Transmission to Remote Alarm Receiving Station (Back-up Dialer): Provide Addressable Relay Modules (FRM-1) and a Digital Alarm Communication Transmitter (DACT) by the Fire Alarm Control panel as indicated. Arrange and program the DACT to route "alarm signals" only to the Campus Police back-up dialer.

K. Transmission to Remote Alarm Receiving Central Network Station: Provide all network programming for identification of devices at the existing fire alarm control panel and at the Central Network Station located at the Campus Police, UMB Fire Marshal’s Office, and Pearl Street Garage Electronics Shop.

L. Provide all network programming on node assigned to each building on the network system.

M. Loss of primary power at FACP initiates trouble signal at FACP and Graphic Annunciator Panel (GAP). Both FACP and GAP shall indicate when fire alarm system is operating on secondary power supply.

N. Basic Alarm Performance Requirements: Unless otherwise indicated, fire alarm signal activation shall initiate the following:

1. Notification-appliance operation:

a. General Alarm – All notification appliances in the building shall activate upon any alarm signals.

b. Voice Message - All floors. Recorded (FEMALE VOICE) message shall be played throughout the building. Final wording of the message shall be submitted with the shop drawings for review and approval.

c. Provide the following recorded (FEMALE VOICE) Testing Message, programmed at the control panel:

"MAY I HAVE YOUR ATTENTION PLEASE, MAY I HAVE YOUR ATTENTION PLEASE. WE ARE CONDUCTING A TEST OF THE FIRE ALARM SYSTEM IN THE BUILDING. DISREGARD ANY EVACUATION ANNOUNCEMENTS YOU MAY HEAR. IF AN ACTUAL EMERGENCY OCCURS YOU WILL BE NOTIFIED." This message shall repeat for 4 times.

d. Provide the following recorded (FEMALE VOICE) Test Completed Message programmed at the control panel:

"MAY I HAVE YOUR ATTENTION PLEASE, MAY I HAVE YOU ATTENTION PLEASE. WE HAVE COMPLETED THE FIRE ALARM TESTING IN THE BUILDING. ANY EVACUATION NOTIFICATION AFTER THIS ANNOUNCEMENT IS FOR REAL. THANK YOU FOR YOUR COOPERATION." This message shall repeat for 4 times.

e. Provide the following recorded (FEMALE VOICE) Maintenance Message programmed at the control panel:

MAY I HAVE YOUR ATTENTION PLEASE, MAY I HAVE YOUR ATTENTION PLEASE. WE ARE PERFORMING MAINTENANCE ON THE FIRE ALARM SYSTEM IN THE BUILDING. DISREGARD ANY EVACUATION ANNOUNCEMENTS YOU MAY HEAR. IF AN ACTUAL EMERGENCY OCCURS YOU WILL BE NOTIFIED." This message shall repeat for 4 times.

f. Provide the following recorded (FEMALE VOICE) Maintenance Completed Message programmed at the control panel:

"MAY I HAVE YOUR ATTENTION PLEASE, MAY I HAVE YOU ATTENTION PLEASE. WE HAVE COMPLETED FIRE ALARM SYSTEM MAINTENANCE IN THE BUILDING. ANY EVACUATION NOTIFICATION AFTER THIS ANNOUNCEMENT IS FOR REAL. THANK YOU FOR YOUR COOPERATION." This message shall repeat for four (4) times.

2. Identify alarm at fire-alarm control unit and remote annunciators.
3. Transmit an alarm signal to the remote alarm receiving station.
4. Unlock all electrical door locks unless directed otherwise by UMB Project Manager.
5. Release fire and smoke doors held open by magnetic door holders.

6. Activate voice/alarm communication system.
7. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
8. Activate smoke-control system (smoke management) at firefighter smoke-control system panel.
9. Activate stairwell and elevator-shaft pressurization systems.
10. Close smoke dampers in air ducts of designated air-conditioning duct systems.
11. Record events in the system memory.
12. Record events by the system printer.
13. Mass Notification Broadcast: In the event of an emergency, if a mass notification message is sent from the Campus Police, the broadcast message shall override the building recorded voice message.

O. Building HVAC System Duct Smoke Detector Control via the BAS: The following requirements apply to all building 'HVAC Systems.' A building HVAC System is defined as an individual air circulation system comprised of a supply air system and a return air system. An HVAC System can be either a 100% outside air system or a re-circulating air system. Prior to making any interface connections to the building HVAC system, the contractor shall coordinate with UMB Project Manager and review building sequence of operations. Existing building (Howard Hall) BAS system is SIEMENS. Contractor shall hire services of SIEMENS to program the existing BAS system such that any activation of the duct smoke detector on the HVAC system shall report the status of the HVAC system to remote BAS network. For new fire alarm system for the new building, the contractor shall coordinate with the BAS contractor and provide all interface connections such that any activation of the duct smoke detector on the HVAC system shall report the HVAC system to remote BAS network.

1. Provide duct smoke detectors in accordance with all applicable codes and standards. Do not provide additional detectors that are not required by code unless specifically requested by UMB.
2. For each duct detector, provide a remote LED indicator for quick identification of the detectors' location. Mount the remote LED at six (6) inches to twelve (12) inches below the ceiling in the wall, or in corridor space or ceiling. Remote LED indicators must be located in the same room as the duct detector or in the corridor directly outside. For detectors located in rooftop HVAC system units, mount the remote LED indicator just inside the units' mantrap door for quick identification. Do not include the test switch option with the remote LED indicator. For detectors located in shafts or remote spaces, mount the remote LED indicator in corridor. Provide device address on the remote LED.
3. The buildings BAS will coordinate the shutdown of an HVAC System and its' associated smoke and fire dampers due to a duct smoke detector activation from the FAS. **Do not perform any direct interconnection between the duct smoke detectors contact outputs and the HVAC System starter(s) and any of its' smoke and fire dampers. Provide a dedicated addressable relay for interface connections.**

4. Provide a dedicated 'FRM-1' addressable relay for each HVAC System with duct smoke detectors regardless of the quantity of duct smoke detectors on the HVAC System. The output from the 'FRM-1' relay will be used to represent a 'shutdown request' to the BAS for the multiple duct smoke detectors on each HVAC System.
5. For each existing and new HVAC System, coordinate with the BAS Contractor and UMB Energy Manager/UMB Project Manager and locate the dedicated 'FRM-1' relay next to the ATC Network Panel that will be used to receive a 'shutdown request' from the FAS due to a duct smoke detector activation.
6. Since most buildings have several HVAC Systems over 2,000 cfm, the above requirements will have several dedicated ‘FRM-1’ relays next to the ATC Panel(s). Again, provide a dedicated ‘FRM-1’ relay for EACH HVAC system with duct smoke detectors and locate them next to the ATC Panel(s). Coordinate with the BAS Contractor and UMB Energy Manager/UMB Project Manager to determine the exact location of EACH of the dedicated ‘FRM-1’ relays.
7. Please refer to the 'Identification' Section in Part 3 for labeling requirements of the HVAC System 'FRM-1' relays.
8. When a duct smoke detector activates, the following sequence of events should occur:

    a. The detector reports a 'supervisory' signal to the FAS which is relayed to the UMB network stations as a 'supervisory' signal.
    b. The FAS will initiate a contact output from the 'FRM-1' relay associated with the detector in alarm to the BAS System Panel which in turn will execute shutting down the HVAC System and closing any associated smoke and fire dampers.

P. Building HVAC System Manual Control & Remote Monitoring:

1. HVAC Systems that do not serve life safety purposes: All responsibility for providing manual override switches, remote LED status indicators, and a building riser (if applicable) has been moved to the BAS System contractor's scope of work. The BAS contractor will provide a dedicated panel next to the GAP for this purpose. This "HVAC System Monitoring and Control Panel" should in no way be interconnected with the FAS.
2. HVAC Systems Dedicated for Life Safety Purposes: The FAS directly monitors and controls all HVAC Life Safety systems such as, Stairwell Pressurization Fans, Atrium Exhaust Systems, etc. Provide the following:

    a. Provide a dedicated 'FRM-1' relay for each fan motor. Using the 'FRM-1' relay provide a control output to start and stop the fan motor and derive a status input from the starter for remote monitoring at the GAP.
    b. At the GAP, provide dedicated key switches for each fan motor and separate 'run' and 'off' status LED's in a separate NEMA 1 enclosure. Provide dedicated addressable modules for interface connections with GAP and FACP.

Q. Alarm Silencing, System Reset and Indication: Controlled by switches in FACP.

1. Silencing-switch operation halts alarm operation of notification appliances and activates alarm silence light. Display of identity of alarm zone or device is retained.
2. Subsequent alarm signals from other devices or zones reactivate notification appliances until silencing switch is operated again.

R. Remote Detector Sensitivity Adjustment: Manipulation of controls at FACP causes selection of addressable smoke detectors for adjustment, display of their current status and sensitivity settings, and control of changes from primary to alternate sensitivity setting. Sensitivity adjustment will be recorded in system memory and printed out by system printer. FAS shall automatically perform sensitivity test at no more than one month intervals.

S. Printout of Events: On receipt of signal, print alarm, supervisory, and trouble events. Identify zone, device, and function. Include type of signal (alarm, supervisory, or trouble), and date and time of occurrence. Differentiate alarm signals from all other printed indications. Also print system reset event, including same information for device, location, date, and time. Commands initiate printout of list of historical log of events.

T. FACP and Remote Alphanumeric Displays: Plain-English-language descriptions of alarm, supervisory, and trouble events; and addresses and locations of alarm-initiating or supervisory devices originating report. Display monitoring actions, system and component status, system commands, programming information, and data from system's historical memory.

## 2.3 FIRE-ALARM CONTROL UNIT

A. General Requirements for Fire-Alarm Control Unit:

1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864 and listed and labeled by an NRTL.

    a. System software and programs shall be held in flash electrically erasable programmable read-only memory (EEPROM), retaining the information through failure of primary and secondary power supplies.
    b. Include a real-time clock for time annotation of events on the event recorder and printer.

2. Addressable initiation devices that communicate device identity and status.

    a. Smoke sensors shall additionally communicate sensitivity setting and allow for adjustment of sensitivity at fire-alarm control unit.
    b. Temperature sensors shall additionally test for and communicate the sensitivity range of the device.

3. Addressable control circuits for operation of mechanical equipment.

B. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.
   1. Annunciator and Display: Liquid-crystal type, NFS2-3030 2 line(s) of 80 characters, minimum.
   2. Keypad: Arranged to permit entry and execution of programming, display, and control commands and to indicate control commands to be entered into the system for control of smoke-detector sensitivity and other parameters.
   3. Password: Contractor shall not change FACU password without written approval from UMB Electronics Shop and UMB Fire Marshal.

C. Circuits:

   1. Initiating Device, Notification Appliance, and Signaling Line Circuits: NFPA 72, Class B, with isolator modules to isolate each floor. Provide 20% spare capacity on each signaling line circuit.

   2. Serial Interfaces: Two RS-232 ports for printers.

D. Stairwell Pressurization: Provide an output signal using an addressable relay to start the stairwell pressurization system. Signal shall remain on until fire-alarm system is reset. Signal shall not stop in response to alarm acknowledge or signal silence commands.

   1. Pressurization starts when any alarm is received at fire-alarm control unit.
   2. Alarm signals from smoke detectors at pressurization air supplies have a higher priority than other alarm signals that start the system.

E. Smoke-Alarm Verification:

   1. Initiate audible and visible indication of an "alarm-verification" signal at fire-alarm control unit.
   2. Activate an NRTL-listed and -approved "alarm-verification" sequence at fire-alarm control unit and detector.
   3. Record events by the system printer.
   4. Sound general alarm if the alarm is verified.
   5. Cancel fire-alarm control unit indication and system reset if the alarm is not verified.

F. Notification Appliance Circuit: Operation shall start with a temporal pattern followed by the recorded voice message and continue alternating between the two.

G. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory

signals, supervisory and digital alarm communicator transmitters, and digital alarm radio transmitters shall be powered by 24-V dc source.

1. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.

H. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.

1. Batteries: Sealed, valve-regulated, recombinant lead acid.

I. Instructions: Provide manufacturers printed instructions inside FACU cabinet door.

J. 'Trouble,' 'Supervisory,' and 'Alarm' Contact Outputs to the UM Central Monitoring Station and Autodialing Systems for new building:

1. Provide six (6) 'FRM-1' relays for remotely reporting 'Trouble,' 'Supervisory,' and 'Alarm' contact outputs to the UMB Network Stations. Only ‘Alarm’ shall report to the Backup dialer System.
2. Mount the six (6) 'FRM-1' relays next to the FACP and put them on the local SLC that serves the floor the FACP is located on.
3. This requirement applies regardless of whether the Fire Alarm Control Panel has some amount of these outputs built into its' circuit boards. Do not use non-addressable, current relays to multiply these built-in outputs for this purpose.

K. UMB Custom Control Switches for FACP: Provide the following custom controls and switches integral to the FACP:

1. Provide an "All Evac." control switch that activates notification appliances on all floors while executing all life safety relays to recall the building elevators, notify the campus police via the remote reporting system, dropping out door holders, and starting any Life Safety HVAC systems (e.g. Stairwell Pressurization Fans, Atrium Exhaust System, etc.).
2. Provide an auto-disable control switch to disable all notification appliances in order to avoid disturbing building occupants during maintenance and/or repair work on the system.
3. Provide an auto-disable control switch to disable all elevator recall.
4. Provide an auto-disable control switch to disable all HVAC systems impacted by activation of the fire alarm system.
5. Provide an auto-disable control switch to disable all automatic door unlocks and all door hold-open magnets.
6. Provide an auto-disable control switch to disable all fire shutters.

L. Self-testing:

1. The FACP shall perform a test at least weekly to check the internal diagnostics of all connected devices. Test shall verify that all detector internal sensitivity levels are within range and if not, then issue a trouble/supervisory signal.

M. The audio amplifiers will provide audio power (@70 Volts RMS) for distribution to speaker circuits. Multiple audio amplifiers may be mounted in a single enclosure, either to supply incremental audio power, or to function as an automatically switched backup amplifier. The audio amplifier shall include an integral power supply and shall provide built-in LED indicators. All the controls shall be built-in to the audio amplifier. System shall be capable of backing up digital amplifiers. Provide model DAA2 series amp.

N. Standby (backup) Audio Amplifiers shall be provided that automatically sense the failure of a primary amplifier, and automatically program themselves to select and de-multiplex the same audio information channel of the failed primary amplifier, and fully replace the function of the failed amplifier. Provide model BDA-70 series amp.

O. The stairwells shall be a dedicated paging zones and the speakers used therein for that purpose only.

P. Audio Message Generator (Prerecorded Voice)/Speaker Control:

1. Each initiating zone or intelligent device shall interface with an emergency voice communication system capable of transmitting a prerecorded voice message to all speakers in the building.
2. Actuation of any alarm initiating device shall cause a prerecorded message to sound over the speakers. The message shall be repeated four (4) times. Pre- and post-message tones shall be supported.
3. A built-in microphone shall be provided to allow paging through speaker circuits.
4. System paging from emergency telephone circuits shall be supported.
5. The audio message generator shall have the indicators and controls to allow for proper operator understanding and control.

Q. Digital Voice Command Center:

1. The Digital Voice Command Center located with the FACP, shall contain all equipment required for all audio control, emergency telephone system control, signaling and supervisory functions. This shall include speaker zone indication and control, telephone circuit indication and control, digital voice units, microphone and main telephone handset.
2. Function: The Voice Command Center equipment shall perform the following functions:

a. Operate as a supervised multi-channel emergency voice communication system.
b. Operate as a two-way emergency telephone system control center.

c. Audibly and visually annunciate the active or trouble condition of every speaker circuit and emergency telephone circuit.
d. Audibly and visually annunciate any trouble condition for digital tone and voice units required for normal operation of the system.
e. Provide all-call Emergency Paging activities through activation of a single control switch.
f. As required, provide vectored paging control to specific audio zones via dedicated control switches.
g. Provide a factory recorded "library" of voice messages and tones in standard WAV. File format, which may be edited and saved on a PC running a current Windows® operating system.
h. Provide a software utility capable of off-line programming for the VCC operation and the audio message files. This utility shall support the creation of new programs as well as editing and saving existing program files. Uploading or downloading the VCC shall not inhibit the emergency operation of other nodes on the fire alarm network.
i. Support an optional mode of operation with four analog audio outputs capable of being used with UL 864 fire-listed analog audio amplifiers and SCL controlled switching.
j. The Digital Voice Command shall be modular in construction, and shall be capable of being field programmable without requiring the return of any components to the manufacturer and without requiring use of any external computers or other programming equipment.
k. The Digital Voice Command and associated equipment shall be protected against unusually high voltage surges or line transients.

## 2.4 MANUAL FIRE-ALARM BOXES

A. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.

1. Manual stations shall be Notifier NBG12-LX. For outdoor locations provide weatherproof manual pull stations Notifier NBG-12LOB.
2. Double-action mechanism requiring two actions to initiate an alarm, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
3. Station Reset: Key- or wrench-operated switch.
4. Weatherproof Protective Shield: Factory-fabricated clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm.
5. Provide manufacturer's optional RED back-boxes for mounting of all fire alarm pull stations.
6. Manual Emergency Exit Door Release Pull Stations: Provide non-addressable, single-action pull stations with one (1) isolated normally-closed and one (1)

isolated normally-open dry contacts. The station shall be of metal construction with an internal toggle switch. Provide a silver sign stating "EMERGENCY EXIT ONLY - PULL MANUAL FIRE ALARM TO OPEN DOOR".

## 2.5 SYSTEM SMOKE DETECTORS

A. General Requirements for System Smoke Detectors:

1. Comply with UL 268; operating at 24-V dc, nominal.
2. Detectors shall be two wire type.
3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
4. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
5. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
6. Integral Visual-Indicating Light: LED type indicating detector has operated and power-on status.
7. Remote Control: Unless otherwise indicated, detectors shall be analog-addressable type, individually monitored at fire-alarm control unit for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by fire-alarm control unit.
   a. Provide multiple levels of detection sensitivity for each sensor.

B. Photoelectric Smoke Detectors shall be Notifier Model # FSP-951

C. Duct Smoke Detectors shall be Notifier Model #DNR with FSP-951R HEAD.

1. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector.
2. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
3. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.

## 2.6 HEAT DETECTORS

A. General Requirements for Heat Detectors: Comply with UL 521.

B. Heat Detectors shall be Notifier Model FST-951 for indoor applications. Heat detectors for unconditioned spaces and parking garages shall be Notifier Model # 302 series.

C. Heat Detector, Combination Type: Actuated by either a fixed temperature of $135^0$F or a rate of rise that exceeds $15^0$F per minute unless otherwise indicated.

1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

D. Heat Detector, Fixed-Temperature Type: Actuated by temperature that exceeds a fixed temperature of $194^0$F.

1. Mounting: Adapter plate for outlet box mounting.
2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

## 2.7 NOTIFICATION APPLIANCES

A. General Requirements for Notification Appliances: Individually addressed, connected to a signaling line circuit, equipped for mounting as indicated and with screw terminals for system connections.
1. Combination Devices: Factory-integrated audible and visible devices in single-mounting assembly.

B. Audio Amplifier Output Capability: Confirm adequate amplification is built into system to support throughout the protected area/space regardless of distance from nearest audible device as well as type of audible device being provided (e.g. speaker, horn, and trumpet).

C. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Comply with UL 464. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet from the horn, using the coded signal prescribed in UL 464 test protocol. Provide horns in mechanical rooms or where indicated on the drawing. Provide Wheelock Model #HNR.

D. Weatherproof Horn/Strobes:
1. Provide weatherproof horn/strobes with weatherproof back boxes as indicated on the drawings.

a. Audible Strobe, Wheelock # ASWP-24MCWH-FR
b. Strobes, Wheelock # AH-24WP-R
c. Back boxes for weatherproof horns/strobes, Wheelock # WPBB-R and WBB-R.

E. Beacon Lights:
1. Provide rotating beacon lights in mechanical rooms or where indicated on the drawings. Edwards # 53DR-GW with WBR mounting bracket.
2. Provide weatherproof flashing beacon lights where indicated on the drawings. Edwards # 125HALFR24A with suitable mounting bracket.

F. Visible Notification Appliances: Xenon strobe lights comply with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum one (1) inch high letters on the lens.

1. Rated Light Output:

a. 15/30/75/110 CD, selectable in the field.

2. Mounting: Recessed wall or ceiling mounted are acceptable.
3. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
4. Flashing shall be in a temporal pattern, synchronized with other units.
5. Strobe Leads: Factory connected to screw terminals.
6. Mounting Faceplate: Factory finished, red.
7. Provide Wheelock Exceeder Series.

G. Speaker/Strobe Notification Appliances:

1. Speakers shall be provided for use with 70v system.
2. High-Range Units: Rated 2 to 15 W.
3. Low-Range Units: Rated 1 to 2 W.
4. Mounting: Recessed wall or ceiling mounted are acceptable.
5. Matching Transformers: Tap range matched to acoustical environment of speaker location.
6. Provide Wheelock E50 Series Speakers/Speaker Strobes.

H. Mount all notification appliances in manufacturer’s optional red boxes.

## 2.8 MAGNETIC DOOR HOLDERS

A. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching doorplate.

1. Electromagnet: Requires no more than 3 W to develop 25-lbf holding force.
2. Wall-Mounted Units: Flush mounted unless otherwise indicated.
3. Rating: 24-V ac or dc.

B. Material and Finish: Match door hardware.

C. Magnetic door holders are not to be served by "emergency" power. Magnetic door holders are released when “normal” power fails.

## 2.9 GRAPHIC DISPLAY ANNUNCIATORS

A. Description: Duplicate annunciator functions of FACP for alarm, supervisory, and trouble indications.

1. Mounting: Flush cabinet, NEMA 250, Class 1. See Contract Drawings for details. If space conditions does not allow for flush mounting, contractor shall coordinate with UMB project manager and get final approval for surface mounted cabinet.

B. Display Type and Functional Performance: Individual LED for each type of alarm and supervisory device, and LEDs to indicate normal power and trouble.

1. An alarm or supervisory signal causes illumination of floor light, device type light, and location.
2. System trouble causes illumination of all lights above and also trouble light.
3. Additional LEDs indicate normal power mode status for system.
4. A test switch tests LEDs mounted on panel. Switch does not require key operation. There shall be no audible signal associated with the testing of the LED's.
5. Graphics: Integrate LED displays with graphic display panel to form graphic annunciator.
6. Battery power on.

C. Graphic Display Annunciator: The Graphic Display Annunciator shall be provided with the following features and as directed by the UMB Fire Marshal.

1. Wall-mounted flush backlit panel indicating building floor plan with **"YOU ARE HERE"** designation in red text.
2. The building graphic shall have a white background and depict the building outline, stair locations (with stair labels), all elevators (with elevator labels), elevator machine rooms, location of the fire alarm control panel, location of fire pump (if any), a North arrow, and any other designations as required by the UMB Fire Marshal.
3. Provide an LED on the building graphic as follows:
   a. "RED" for Alarm/Normal Power failure, "YELLOW" for Supervisory and "GREEN" for Normal.
   b. An "LED" shall also be provided to identify floor, device type, and location.
   c. Pull Station – 'RED'.
   d. Smoke detector – "RED'.
   e. Heat detector – "RED".
   f. Water flow – 'RED'.
   g. Duct detector – 'YELLOW'.
   h. Tamper switch – "YELLOW".
   i. Fire Pump Running – "RED".
   j. Fire Pump Trouble – "YELLOW'.

k. Fire Pump Normal - “GREEN”.
l. Halon System – “YELLOW”.
m. Beam detector – “YELLOW”.

D. Materials: Anodized aluminum frame with graphics on white Plexiglas protected by non-glare Plexiglas.

E. Floor plan lines are to be black and all text shall be black one quarter (1/4) inch high minimum, except for “YOU ARE HERE,” fire pump and FACP, which shall be red text.

F. Mounting: Integral with lamp-type annunciator.

G. Provide graphic annunciator as manufactured by QED or approved equal.

H. Trouble signal shall not light for the same event when a supervisory signal is illuminated.

I. Prior to fabrication of the Graphic Annunciator Panel the contractor shall submit final layout of the Graphic Annunciator Panel for approval by UMB Fire Marshal. Any errors or omissions on the graphic annunciator panel are the responsibility of the contractor at no additional cost to the owner.

J. Update existing Graphic Annunciator Panel as necessary for updated floor plans and/or changes to device locations.

## 2.10 ADDRESSABLE INTERFACE DEVICE

A. Description: Microelectronic monitor module, NRTL listed for use in providing a system address for alarm-initiating devices for wired applications with normally open contacts.

## 2.11 CONTROL RELAY AND CONTACT INPUT MODULES

A. Description: Units are equipped for wall mounting, complete with red enclosures.
1. Wall-Mounted Units: Flush mounted, unless otherwise indicated.
2. Rating: 120-VAC.
3. Provide auxiliary control relays and required control power circuiting for all life safety relay functions (e.g. elevator recall, door holder release, electric door lock release, notifying the backup auto dialer system, etc.). Provide dedicated relays for each door holder installation (i.e. do not use current relays or use riser wiring), electric door lock location, and for alarm signals being reported to the auto dialer. Relays must be UL listed and compatible with the fire alarm system manufacturer's equipment.
4. Provide a dedicated 'FDM-1' module for each set of Sprinkler System Flow Switch and Tamper switch locations. In other words, provide a dedicated addressable point/signal for each Flow Switch, Tamper Switch, etc. do not combine or parallel tamper and/or flow switches to a single fire alarm system

relay input. This slows down UMB's ability to quickly locate the source of a constant alarm or trouble signal.

5. Provide a dedicated 'FRM-1' relay for each building HVAC System with duct smoke detectors as noted earlier.
6. Provide a dedicated 'FRM-1' relay for each locked building exit door with a manual pull station that is required to be tied into the Fire Alarm System. Refer to Door Hardware Schedule for further details.
7. Mount all relays in FAS manufacturer's red enclosures.

## 2.12 DIGITAL ALARM COMMUNICATOR TRANSMITTER – (BACK-UP DIALER)

A. Digital alarm communicator transmitter shall be compatible with the UMB Police Station back-up dialer and shall comply with UL 632.

B. Functional Performance: Unit shall receive an alarm from the fire-alarm control unit and automatically capture one telephone line and dial a preset number for a remote central station. When contact is made with central station(s), signals shall be transmitted. If service is interrupted for longer than forty five (45) seconds, transmitter shall initiate a local trouble signal.

C. Local functions and display at the digital alarm communicator transmitter shall include the following:

1. Verification that telephone lines are available.
2. Programming device.
3. LED display.
4. Manual test report function and manual transmission clear indication.
5. Communications failure with the central station or fire-alarm control unit.

D. Digital data transmission shall include the following:

1. Alarm signal.
2. Loss of ac supply or loss of power.
3. Low battery.
4. Abnormal test signal.
5. Communication bus failure.

E. Secondary Power: Integral rechargeable battery and automatic charger.

F. Self-Test: Conducted automatically every twenty four (24) hours with report transmitted to central station.

G. Where indicated on the drawings and as required, provide Notifier Model #411UDAC back-up dialer, installed in a separate enclosure. Final connection of the dialer shall be coordinated with UMB Electronics Shop.

H. The existing receiver unit at the Central Station is Honeywell MX-8000.

## 2.13 INTERFACE CONNECTIONS TO EXISTING CAMPUS CENTRAL NETWORK STATIONS

A. General:

1. The existing Campus – wide Central Fire Alarm Monitoring & Control (FAMC) and Mass Notification System (MNS) is Fiber based through campus fiber network. The FAMC system consist of three (3) Network Command Centers (NCC) with PC based head-end work stations with graphical user interfaces that allow for centralized alarm annunciation, monitoring and control at each NCC of all building fire alarm systems, their respective individual signaling line circuits, notification appliance circuit loops and associated individual devices. The NCC's also has the capability to remotely broadcast real-time and pre-recorded voice messages via a microphone at Campus Police. The three (3) NCC's are located at Campus Police, the UMB Fire Marshal's Office and in the Pearl Street Garage Electronics Shop.

2. The existing FAMC, MNS & NCC is Notifier ONYX WORKS – NW Work Stations with HS-NCM-MF high speed network communications modules, Graphic User Interface software and hardware for NOTI-FIRE NET (NFN) with Gateway.

B. Under This Project Provide the following for a fully operational FAMS & MNS capabilities for new building or existing building as follows:

1. In new Fire Alarm Control Unit/Fire Alarm Control Panel provide the following Network Communications Modules:

   a. High-Speed Network Communications Module type HS-NCM-MF for communications with Fire Alarm Control Unit/Fire Alarm Control Panel.
   b. High-Speed Network Communications Module type HS-NCM-MF for communications with Digital Voice Command (DVC) with Fire Alarm Control Unit/Fire Alarm Control Panel.
   c. Provide fiber jumper cables for interconnections within the Fire Alarm Control Unit/Fire Alarm Control Panel in accordance with manufacturer's requirements and recommendations. Provide fiber jumper cables from Fire Alarm Control Unit/Fire Alarm Control Panel to fiber optic patch panel.

2. The existing three (3) NCC Network Command Centers have been upgraded under a separate contract and are still under warranty with M.C. Dean, Inc. All work associated with the connections, programming, and modifications to the existing Network Command Centers must be performed by M.C. Dean, Inc. UMB will hire M.C. Dean, Inc. under a separate service contract to perform all work.

This contractor will be responsible for coordinating all work with M.C. Dean, Inc to perform all work related to upgrading/modifications to three (3) Network Command Centers. M.C. Dean, Inc. will provide the work as follows:

a. Programming of the network stations to communicate with building Fire Alarm Control Unit/Fire Alarm Control Panel.
b. Convert CADD files to META files for Graphic User Interface and upload on to NCC's.
c. Provide complete Point ID descriptions and locations of devices for new graphic screen shots.
d. Program and test all new Point ID's.
e. Program and test Mass Notification Message Broadcast.
f. Provide all hardware, software, programming tools and documentation necessary to modify the system on site. Modification includes addition and deletion of devices, circuits, zones and changes to system operation and custom label changes for devices or zones. The system structure and software shall place no limit on the type or extent of software modifications on-site.

3. Before M.C. Dean, Inc. can perform the work on the existing Network Stations, the contractor shall provide M.C. Dean, Inc. updated and approved as-built fire alarm system shop drawings hard copy and CADD files, with exact device locations and addresses, as well as the updated building FACP program.

4. From new Fire Alarm Control Unit/Fire Alarm Control Panel provide the following Fiber Optic Network Communications capability:

a. The network shall be capable of communicating via fiber optic medium. Shall be a hybrid cable multimode under a single plenum jacket, RED color unless otherwise noted.
b. The network shall support fiber optics with the following specifications: OM1 12 strand Multimode-62.5/125 micrometers tight buffer construction with aramid yarn strength member, plenum jacket, indoor/outdoor rated, maximum 8dB total attenuation between nodes with connector type LC. Manufacturer: OCC #DX012KSLX9RP16.
c. From Fire Alarm Control Unit/Fire Alarm Control Panel provide two (2) pair multimode fiber patch cords to fiber optic patch panel.

5. From Saratoga Garage Building, fiber optic patch panel provide new OM1 12 strand Multimode fiber routed in EMT conduit to incoming telecommunications duct bank and thru existing communications duct bank in existing manholes to new Master Switching Station. Provide inner duct in existing duct bank to route the new fiber. Terminate new fiber in new fiber patch panel in new Master Switching Station. From new fiber patch panel in New Master Switching Station provide new OM1 12 strand Multimode fiber routed in EMT conduit to incoming telecommunications duct bank and thru existing communications duct bank in

existing manholes to existing fiber patch panel located in Main Electric Room of Pine Street Annex building. Coordinate with UMB Project Manager and terminate new fiber cables at both ends for a complete Class A Loop. After this fiber cable installation is complete, the contractor shall remove existing fiber cable that was previously routed from Saratoga Garage to Pine Street Annex building.

6. Termination Hardware:

   a. Wall-mounted optical fiber patch panel with hinged front door, mounting guides, and designation panels.

   b. Manufacturer: Siecor/Corning. Panel Housing #WCH-049, Connector Panels #(2)-CCH-CP12-A8 12 count (6 duplex) LC OM1 Multimode connector panel.

## 2.14 EMERGENCY POWER SUPPLY

A. General: Components include nickel-cadmium battery, charger, and automatic transfer switch.

   1. Battery Nominal Life Expectancy: Twenty (20) years, minimum.

B. Battery Capacity: Comply with NFPA 72.

C. Battery Charger: Solid-state, fully automatic, variable-charging-rate type. Provide capacity for 150 % of connected system load while maintaining batteries at full charge. If batteries are fully discharged, charger recharges them completely within four hours. Charger output is supervised as part of system power supply supervision.

D. Integral Automatic Transfer Switch: Transfers load to battery without loss of signals or status indications when normal power fails.

## 2.15 DEVICE GUARDS

A. Description: Welded wire mesh of size and shape for the manual station, smoke detector, gong, or other device requiring protection.

   1. Factory fabricated and furnished by manufacturer of device.
   2. Finish: Paint of color to match the protected device.

## 2.16 REMOTE POWER SUPPLY PANEL

A. Where required on the Contract Drawings, provide the following Remote Power Supplies Panel with battery charger:

1. Panel shall be Notifier Model #FCPS-24S8, as needed to provide sufficient power for notification circuits. Include batteries sized to provide twenty four (24) hour battery backup. Provide enclosure sized to support the above equipment.
2. In each FCPS, provide FM-101 monitoring module to individually monitor trouble at FACP.
3. FCPS (FABP) shown on the drawings is preliminary and reflect the design intent only. Contractor shall verify system power supply requirements and confirm quantity of power supplies needed.

## 2.17 SYSTEM PRINTER

A. Description: Separately mounted twenty four (24) pin 'dot-matrix' printer.

B. Provide portable stand for printer with paper storage space. Stand should be roughly three (3) feet H x two (2) feet W x two (2) feet deep. Confirm size with dimensions of dot-matrix printer.

## 2.18 WIRE

A. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 C, color-coded insulation.

1. Low-Voltage Circuits: No. 16 AWG, minimum.
2. Line-Voltage Circuits: No. 12 AWG, minimum.

B. Power-Limited Circuits: NFPA 70, Types FPL, FPLR, or FPLP, as recommended by manufacturer.

1. For use on fire alarm circuits as required.
2. Continuous red identifying stripe.
3. UL Listed Fire Alarm Cable.
4. Rated for use in plenums.
5. Rated for through penetrations of one (1), two (2), and three (3) hour fire walls.
6. Individually twisted pairs and shielding, as required per fire alarm system manufacturer.
7. Fire resistant and low smoke.
8. NEC compliant.

C. Refer to Part 3 under "Grounding and Shielding" for additional cabling/wiring requirements and their applicability for the FAS wiring provided. Confirm all shield and grounding requirements with equipment vendor prior to installing any FAS circuit wiring.

## 2.19 LINE-ISOLATION MODULES

A. Provide minimum one ISO-X per floor, maximum twenty five (25) devices per ISO-X.

## 2.20 KNOX BOX

A. Obtain a signed copy of the "Fire/Police Rapid Entry System - Authorization/Order Form" from the UMB Fire Marshal and provide the Knox Box in the Fire Command Center, building Main Lobby, or outside the building as approved by the UMB Fire Marshal.

1. KNOX-BOX 4403 Series with dual-key and Hinged Door (KNOX-BOX phone #800-552-5669).

    a. Recess Mount in optional Recessed Mounting Kit (RMK).
    b. Black finish color.
    c. Provide at least four (4) key hooks inside the knox box.

## 2.21 TRANSIENT PROTECTION

A. Provide transient protection at the source panel for the following circuits at the specified locations that maybe vulnerable to voltage swells in the event of a lightning strike, ground swell or other phenomena. Although it may not entirely safeguard field wiring and/or devices, it will minimize the spread of loss to the more costly FAS Panel Circuit Boards.

B. 120VAC Power Circuits: Provide Silicone Surge Suppression for 120VAC to all control panel, transponder panel, graphic annunciator panels' and any other FAS power supplies. Mount surge suppressors at panel power supply terminals.

C. Low-Voltage, Shielded & Non-Shielded, Power-Limited Circuits: Provide Silicone Surge Suppression for the following low-voltage circuits that serve the following locations:

1. SLC & NAC (including speaker, voice audio, strobe, and horn): The top three (3) levels/floors; the bottom two (2) levels/floors; and all stairwells regardless of length of run in stairwell.
2. Phone & Network Phone: The top three (3) levels/floors; bottom two (2) levels/floors; and all stairwells regardless of length in stairwell.
3. FAS Backbone Network Loops: Protect ALL FAS Network and Network Data Circuits. The protected runs will include, but NOT be limited to, the following:

    a. FACP - Transponder; Transponder - Transponder; Transponder - FACP.
    b. GAP - FACP; FACP - remote printer; GAP - remote printer.
    c. GAP - Remote Annunciator; FACP - Remote Annunciator; Remote Annunciator - Transponder.

4. Low-Voltage Power Circuit Risers: All low-voltage power circuit risers located in and/or serving stairwell devices.

2.22 REMOTE MICROPHONE WITH CABINET

A. Where indicated on the plans, provide Notifier Model RM-1remote microphone in cabinet and Emergency Telephone Station adjacent to the Graphic Annunciator Panel in the lobby.

**PART 3 - EXECUTION**

3.1 EQUIPMENT INSTALLATION

A. Comply with NFPA and manufacturers installation instructions for installation of all fire-alarm equipment, devices and appliances.

B. Equipment Mounting: Install fire-alarm control unit on concrete base with tops of cabinets not more than seventy two (72) inches above the finished floor.

1. Connect new equipment to existing control panel in existing part of the building.
2. Connect new equipment to existing monitoring equipment at the supervising station.
3. Expand, modify, and supplement existing control monitoring equipment as necessary to extend existing control monitoring functions to the new points. New components shall be capable of merging with existing configuration without degrading the performance of either system.

C. Remote Status and Alarm Indicators: Install near each sprinkler water-flow switch and valve-tamper switch.

3.2 CONNECTIONS

A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Door Hardware section. Connect hardware and devices to fire-alarm system.

1. Verify that hardware and devices are NRTL listed for use with fire-alarm system in this Section before making connections.

B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than three (3) feet from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.

1. Smoke dampers in air ducts of designated air-conditioning duct systems.
2. Alarm-initiating connection to activate emergency shutoffs for gas and fuel supplies.
3. Supervisory connections at valve supervisory switches.
4. Supervisory connections at low-air-pressure switch of each dry-pipe sprinkler system.
5. Supervisory connections at fire-pump power failure including a dead-phase or phase-reversal condition.
6. Supervisory connections at fire-pump engine control panel.

C. For each tamper, flow and pressure switch on the sprinkler system, provide a dedicated address point. DO NOT “DAISY CHAIN” OR “PARALLEL” tamper, flow or pressure switch to a common addressing point or monitoring module.

## 3.3 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Identification for Electrical Systems section.

B. SLC Loop Devices: Label all SLC loop devices to note the device address and purpose.

C. Where EOL resisters have been installed for SLC or NAC circuits at device/junction box, panel etc., provide label, “EOL RESISTER__OHMS SLC OR NAC CIRCUIT #.

D. Fire Alarm System Conduits and Cabling: Label all FAS raceway/conduit at every floor for vertical runs; at each penetration to a junction box, transponder panel, security panel, etc.; every ten (10) feet to fifteen (15) feet in concealed accessible areas (horizontal runs) and every twenty five (25) feet in exposed areas (horizontal runs) per UMB Standards. Wording for the FAS Raceway and Cabling shall be as follows:

1. FAS Backbone Network Loop: to read "FAS Vertical Network Loop – XX/0."
2. FAS Device Loop: to read "FAS Notification and Signal Appliance Loop XX Floor – XX/0."

E. Fire Alarm System Cabling Installed Exposed in Concealed Ceilings without Being in Raceway: Verbiage and Spacing of labeling shall be as stated above except labels shall be attached directly to cable jackets. Maximum length of label is not important.

F. Fire Alarm System Junction Boxes and Outlets Including Relay Modules: All fire alarm system junction boxes, outlets and covers shall be : “RED” in color and labeled as per the following:

1. Junction Boxes: Same as raceway serving the junction box. Otherwise, to read "Fire Alarm System – XX/0."
2. Relay Modules: to read "_____ Building FAS XXth Floor [Door Holder], [or Generator Monitoring], [or Elevator Recall], [or AHU ____ Duct Smoke

Shutdown], [or Door Release], [or Alarm, Supervisory, Trouble Output to Remote HONEYWELL, Backup System] [or Alarm, Supervisory, Trouble Output to Remote, Network System]– XX/0."

G. HVAC System 'FRM-1' Relay Duct Smoke Detector 'Shutdown Requests': Label each 'FRM-1' relay located at the ATC Panel(s) to identify its' address, purpose, and the individual HVAC System that it controls. For example, "HVAC System No. ___ Duct Smoke Detector Shutdown" - Address 62-51.

## 3.4 WIRING INSTALLATION

A. Wiring Method:
   1. Install wiring in metal raceway according to Raceways and Boxes section, unless otherwise directed on the contract drawings. Conceal raceway except in unfinished spaces and as indicated. DO NOT conceal fire alarm conduits in slabs.

B. Wiring Method:
   1. Wiring Method: Provide all new wiring for the new fire alarm system. For exposed structure install wiring in EMT conduit. In concealed spaces provide plenum rated fire alarm cable. Plenum rated cables shall not be strapped, taped, or attached by any means to the exterior of any conduit, raceway, piping, ceiling grid or ductwork as means of support. Plenum cables shall be independently supported from the ceiling structure with J-hooks at four (4) feet intervals. For exposed structures outdoors and in parking garages install wiring in schedule 40 PVC conduits above six feet. For exposed and subject to severe physical damage, provide wiring in rigid steel conduit. Provide expansion joint fittings as required. Where existing conduits are being utilized, do not use existing in-slab conduits.

C. Wiring within Enclosures: Separate class 1 power-limited and class 2/class 3 non-power-limited conductors as recommended by manufacturer. Provide terminations of class 1 power-limited and class 2/class 3 non-power-limited conductors in all system components as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with fire alarm system to terminal blocks. Mark each terminal according to system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

D. Wire Nuts, Straight Connectors, Terminal Strips, etc.: The use of wire nuts, straight connectors, terminal strips, etc. for cable splicing is absolutely prohibited. Pull new cable to the nearest upstream and downstream devices when adding new devices to an existing SLC and/or NAC.

E. SLC and/or NAC 'T' Taps: 'T' taps are strictly prohibited on both SLC and NAC loops.

F. Color-Coding: Color-code fire alarm conductors differently from normal building power wiring. Use one color-code for alarm circuit wiring and different color-code for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices.

G. Risers: Install at least two vertical cable risers to serve fire alarm system. Separate risers in close proximity to each other with minimum one-hour-rated wall, so loss of one riser does not prevent receipt or transmission of signal from other floors or zones.

## 3.5 GROUNDING

A. Ground fire-alarm control unit and associated circuits; comply with IEEE. Install a ground wire from main service ground to fire-alarm control unit.

B. Ground cable shields and equipment according to system manufacturer's written instructions to eliminate shock hazard and to minimize, to greatest extent possible, ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

C. Specific Shielding and Grounding Requirements: Unless directed otherwise by the equipment vendor, provide circuit shielding and grounding as per the following:

1. All circuits except for speaker circuits must be shielded.
2. All circuit shields must be continuous at the field devices and only be grounded at the point of origin (i.e. the FACP or remote transponder panel).
3. All Backbone Network Loop wiring must be shielded with the shields tied together at each drop (i.e. the transponder panels) and grounded at the FACP.
4. Addressable Relays: All addressable relay module circuit boards must be grounded (unless otherwise instructed by vendor) and their shield wires continuous OR the boards not grounded and the shield wiring be used as the grounding conductor.
5. Where FAS circuits are run in non-metallic raceway, the above requirements must be followed to ensure adequate grounding and shield protection is provided.

D. Signal Ground Terminal: Locate at main equipment rack or cabinet. Isolate from power system and equipment grounding.

E. Install grounding electrodes of type, size, location, and quantity as indicated. Comply with installation requirements in Grounding and Bonding section.

F. Ground equipment and conductor and cable shields. For audio circuits, minimize, to greatest extent possible, ground loops, common-mode returns, noise pickup, cross talk, and other impairments. Provide 5-ohm ground at main equipment location. Measure, record, and report ground resistance.

G. Ground radio alarm transmitter system and equipment as recommended by manufacturer.

3.6 FIELD QUALITY CONTROL

A. Final Acceptance test shall be witnessed by the UMB Fire Marshal.

B. Prior to testing of the system with the UMB Fire Marshal, the contractor shall conduct pre-testing of the system and correct all deficiencies.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

D. Tests and Inspections:

1. Visual Inspection: Conduct visual inspection prior to testing.

a. Inspection shall be based on completed Record Drawings and system documentation that is required by NFPA 72 in its "Completion Documents, Preparation" Table in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter.
b. Comply with "Visual Inspection Frequencies" Table in the "Inspection" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.

E. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.

F. Fire-alarm system will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

H. Contractor Pretesting: After installation, align, adjust, and balance system and perform complete pretesting. Determine, through pretesting, compliance of system with requirements of Drawings and Specifications. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new ones, and retest until satisfactory performance and conditions are achieved. Prepare forms for systematic recording of acceptance test results. Provide documentation summarizing pretesting to UMB Fire Marshal. Documentation should include statement that system is working properly and summary of corrections made during pretesting.

I. Final acceptance testing with the UMB Fire Marshal: After installation, align, adjust, and balance system and perform complete testing with the UMB Fire Marshal.

J. Final Test Notice: Provide minimum of ten (10) days' notice in writing when system is ready for final acceptance testing.

K. All testing will be verified at the main fire alarm control panel, at the building annunciator panel, and at the Campus Police Network Command Center. The contractor is responsible for providing all necessary personal to accomplish this testing at these three locations in addition to in the field.

L. All required testing materials shall be provided by the contractor.

## 3.7 DEMONSTRATION

A. General: Comply with Section 01800. Engage factory-authorized service representative to train Owner's maintenance personnel as specified below:

1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, adjusting, and maintaining equipment and schedules. Provide minimum of four (4) hours' training.
2. Training Aid: Use approved final version of operation and maintenance manual as training aid.
3. Schedule training with Owner with at least seven (7) days' advance notice.

## 3.8 ON-SITE ASSISTANCE

A. Occupancy Adjustments: When requested within one (1) year of date of Substantial Completion, provide on-site assistance in adjusting sound levels, controls, and sensitivities to suit actual occupied conditions. Provide up to three requested visits to Project site for this purpose.

## 3.9 CLEANING AND ADJUSTING

A. Cleaning: Comply with Section 01740. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and marred finish to match original finish. Clean unit internally using methods and materials recommended by manufacturer.

## 3.10 TESTING

Fiber optic cable installed between two buildings shall be tested end to end from both directions, bandwidth 850 and 1300 nm for multi-mode fiber, using optical time domain reflector meter (OTDR).

## 3.11 REPAIRS & RESTORATION OF SURFACES AND FINISHES:

A. Restore all finishes, equipment and surfaces to original condition, where affected by the work. Provide the following, where applicable, in accordance with accepted trade stand-

ards and to Owner's satisfaction:

1. Replace damaged ceiling tiles.
2. Replace ceiling tiles where removal has left holes or cuts in original tiles.
3. Patch, repair and repaint all walls and surfaces cut, penetrated or otherwise disturbed by the work.
4. Patch holes and penetrations in wood, masonry and plaster.
5. Provide suitable cover plates for all recessed back boxes of equipment removed and not covered by new devices.
6. Provide larger trim or cover plates for new devices, where old back boxes, holes, etc. are not concealed by new work.

END OF SECTION 283111

# SECTION 024119 - SELECTIVE DEMOLITION

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:

1. Demolition and removal of selected portions of building or structure.
2. Demolition and removal of selected site elements.
3. Salvage of existing items to be reused or recycled.

B. Related Requirements:

1. Section 011000 (Summary of Work) for restrictions on the use of the premises, Owner-occupancy requirements, and phasing requirements.
2. Section 017300 (Cutting and Patching) for cutting and patching procedures.
3. Section 311000 (Site Clearing) for site clearing and removal of above- and below-grade improvements.

### 1.3 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: Carefully detach from existing construction, in a manner to prevent damage, and deliver to Owner ready for reuse.

C. Remove and Reinstall: Detach items from existing construction, prepare for reuse, and reinstall where indicated.

D. Existing to Remain: Existing items of construction that are not to be permanently removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

### 1.4 MATERIALS OWNERSHIP

A. Unless otherwise indicated, demolition waste becomes property of Contractor.

B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Owner that may be uncovered during demolition remain the property of Owner.

1. Carefully salvage in a manner to prevent damage and promptly return to Owner.

## 1.5 PREINSTALLATION MEETINGS

A. Predemolition Conference: Conduct conference at Project site.

1. Inspect and discuss condition of construction to be selectively demolished.
2. Review structural load limitations of existing structure.
3. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
4. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.
5. Review areas where existing construction is to remain and requires protection.

## 1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For refrigerant recovery technician.

B. Proposed Protection Measures: Submit report, including drawings, that indicates the measures proposed for protecting individuals and property**,** for environmental protection, for dust control and, for noise control. Indicate proposed locations and construction of barriers.

C. Schedule of Selective Demolition Activities: Indicate the following:

1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure Owner's facility manager's on-site operations are uninterrupted.
2. Interruption of utility services. Indicate how long utility services will be interrupted.
3. Coordination for shutoff, capping, and continuation of utility services.
4. Use of elevator and stairs.
5. Coordination of Owner's continuing occupancy of portions of existing building and of Owner's partial occupancy of completed Work.

D. Inventory: Submit a list of items to be removed and salvaged and deliver to Owner prior to start of demolition.

E. Predemolition Photographs or Video: Submit before Work begins.

F. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.

G. Warranties: Documentation indicated that existing warranties are still in effect after completion of selective demolition.

## 1.7 CLOSEOUT SUBMITTALS

A. Inventory: Submit a list of items that have been removed and salvaged.

B. Landfill Records: Indicate receipt and acceptance of hazardous wastes by a landfill facility licensed to accept hazardous wastes.

## 1.8 QUALITY ASSURANCE

A. Refrigerant Recovery Technician Qualifications: Certified by an EPA-approved certification program.

## 1.9 FIELD CONDITIONS

A. Owner will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted.

B. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.

C. Notify Engineer of discrepancies between existing conditions and Drawings before proceeding with selective demolition.

D. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.

1. Hazardous materials will be removed by Owner before start of the Work.
2. If suspected hazardous materials are encountered, do not disturb; immediately notify Engineer and Owner. Hazardous materials will be removed by Owner under a separate contract.

E. Hazardous Materials: Hazardous materials are present in buildings and structures to be selectively demolished. A report on the presence of hazardous materials is on file for review and use. Examine report to become aware of locations where hazardous materials are present.

1. Hazardous material remediation is specified elsewhere in the Contract Documents.
2. Do not disturb hazardous materials or items suspected of containing hazardous materials except under procedures specified elsewhere in the Contract Documents.
3. Owner will provide material safety data sheets for suspected hazardous materials that are known to be present in buildings and structures to be selectively demolished because of building operations or processes performed there.

F. Historic Areas: Demolition and hauling equipment and other materials shall be of sizes that clear surfaces within historic spaces, areas, rooms, and openings, including temporary protection, by 12 inches or more.

G. Storage or sale of removed items or materials on-site is not permitted.

H. 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.

1.10 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. Notify warrantor before proceeding.

B. Notify warrantor on completion of selective demolition, and obtain documentation verifying that existing system has been inspected and warranty remains in effect. Submit documentation at Project closeout.

## PART 2 - PRODUCTS

2.1 PEFORMANCE REQUIREMENTS

A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

B. Standards: Comply with ANSI/ASSE A10.6 and NFPA 241.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Verify that utilities have been disconnected and capped before starting selective demolition operations.

B. Review record documents of existing construction provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in record documents.

C. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.

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.

E. Engage a professional engineer to perform an engineering survey of condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during selective building demolition operations.

1. Perform surveys as the Work progresses to detect hazards resulting from selective demolition activities.
2. Steel Tendons: Locate tensioned steel tendons and include recommendations for de-tensioning.

F. Survey of Existing Conditions: Record existing conditions by use of measured drawings and preconstruction photographs or preconstruction videotapes.

1. Comply with requirements specified in Section 013233 "Photographic Documentation."
2. Inventory and record the condition of items to be removed and salvaged. Provide photographs or video of conditions that might be misconstrued as damage caused by salvage operations.
3. Before selective demolition or removal of existing building elements that will be reproduced or duplicated in final Work, make permanent record of measurements, materials, and construction details required to make exact reproduction.

### 3.2 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.

1. Comply with requirements for existing services/systems interruptions specified in Section 011000 "Summary."

B. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off indicated utility services and mechanical/electrical systems serving areas to be selectively demolished.

1. Owner will arrange to shut off indicated services/systems when requested by Contractor.
2. Arrange to shut off indicated utilities with utility companies.
3. If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
4. Disconnect, demolish, and remove fire-suppression systems, plumbing, and HVAC systems, equipment, and components indicated to be removed.

    a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
    b. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
    c. Equipment to Be Removed: Disconnect and cap services and remove equipment.
    d. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
    e. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
    f. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
    g. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.

C. Refrigerant: Remove refrigerant from mechanical equipment to be selectively demolished according to 40 CFR 82 and regulations of authorities having jurisdiction.

## 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. Comply with requirements for access and protection specified in Section 015000 "Temporary Facilities and Controls."

B. Temporary Facilities: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.

1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.

2. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.
3. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
4. Cover and protect furniture, furnishings, and equipment that have not been removed.
5. Comply with requirements for temporary enclosures, dust control, heating, and cooling specified in Section 015000 "Temporary Facilities and Controls."

C. Temporary Shoring: Provide and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.

1. Strengthen or add new supports when required during progress of selective demolition.

## 3.4 SELECTIVE DEMOLITION, GENERAL

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 and as follows:

1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.
2. 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. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, to minimize disturbance of adjacent surfaces. Temporarily cover openings to remain.
3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
4. 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.
5. Maintain adequate ventilation when using cutting torches.
6. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
7. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
8. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.

9. Dispose of demolished items and materials promptly. Comply with requirements in Section 017419 "Construction Waste Management and Disposal."

B. Reuse of Building Elements: Project has been designed to result in end-of-Project rates for reuse of building elements as follows. Do not demolish building elements beyond what is indicated on Drawings without Engineer's approval.

C. 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 Owner.
4. Transport items to Owner's storage area designated by Owner.
5. Protect items from damage during transport and storage.

D. Removed and Reinstalled Items:

1. Clean and repair items to functional condition adequate for intended reuse.
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.

E. 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 cleaned and reinstalled in their original locations after selective demolition operations are complete.

## 3.5 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

A. Concrete: Demolish in small sections. Using power-driven saw, cut concrete to a depth of at least 3/4 inch at junctures with construction to remain. Dislodge concrete from reinforcement at perimeter of areas being demolished, cut reinforcement, and then remove remainder of concrete. Neatly trim openings to dimensions indicated.

B. Concrete: Demolish in sections. Cut concrete full depth at junctures with construction to remain and at regular intervals using power-driven saw, then remove concrete between saw cuts.

C. Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw, then remove masonry between saw cuts.

D. Concrete Slabs-on-Grade: Saw-cut perimeter of area to be demolished, then break up and remove.

E. Resilient Floor Coverings: Remove floor coverings and adhesive according to recommendations in RFCI's "Recommended Work Practices for the Removal of Resilient Floor Coverings"

F. Roofing: Remove no more existing roofing than what can be covered in one day by new roofing and so that building interior remains watertight and weathertight.

1. Remove existing roof membrane, flashings, copings, and roof accessories.
2. Remove existing roofing system down to substrate.

## 3.6 DISPOSAL OF DEMOLISHED MATERIALS

A. General: Except for items or materials indicated to be recycled, reused, salvaged, reinstalled, or otherwise indicated to remain Owner's property, remove demolished materials from Project site and legally dispose of them in an EPA-approved landfill.

1. Do not allow demolished materials to accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
3. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
4. Comply with requirements specified in Section 017419 "Construction Waste Management and Disposal."

B. Burning: Do not burn demolished materials.

C. Disposal: Transport demolished materials off Owner's property and legally dispose of them.

## 3.7 CLEANING

A. 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.

END OF SECTION 311000

# SECTION 312000 -EARTH MOVING

## PART 1 - GENERAL

### 1.1 SCOPE OF WORK

A. Excavation and preparing of sub grade for concrete sidewalks and curbs, and related areas.

B. Backfilling, grading and finish grading.

### 1.2 SUBMITTALS

A. Test Reports: Submit the following directly to the Engineer from the testing service, with one (1) copy to the Contractor.

1. Test reports on borrow material.

## PART 2 - PRODUCTS

### 2.1 SELECT BORROW EXCAVATION

A. Comply with Section 31 23 16.12 of the Baltimore City Baltimore City Standard Specifications.

### 2.2 SALVAGED TOPSOIL

A. Comply with Section 31 14 13.24 of the Baltimore City Baltimore City Standard Specifications.

### 2.3 FILL MATERIALS

A. Subsoil Reused or Imported: See Baltimore City Standard Specification Section 31 14 13.24.

## PART 3 - EXECUTION

## 3.1 EXAMINATION AND PREPARATION

A. Identify required lines, levels, contours and datum.

B. Notify Engineer of unexpected subsurface conditions and discontinue affected work in area until notified to resume work.

C. Identify and flag utility locations. Maintain and protect existing utilities to remain.

D. Install sediment control devices (silt fences, stabilized construction entrances, curb inlet protection, clear water diversion fences, etc.) for all unpaved disturbed areas. The Contractor shall be responsible for inspecting and maintaining all installed sediment control measures through the duration of the work.

## 3.2 EXCAVATION FOR INCIDENTAL CONSTRUCTION

A. Comply with requirements 31 23 16.17 of the Baltimore City Baltimore City Standard Specifications.

## 3.3 TRENCH EXCAVATION FOR PIPES AND CONDUIT

A. Comply with requirements of Section 31 23 33 of the Baltimore City Baltimore City Standard Specifications.

## 3.4 GRADING

A. General: Uniformly grade areas within limits of grading under this section, including adjacent transition areas. Smooth finished surface within specified tolerances, compact with uniform levels or slopes between points where elevations are indicated or between such points and existing grades.

## 3.5 PLACING TOPSOIL

A. Comply with requirements 31 14 13.24 of the Baltimore City Baltimore City Standard Specifications.

B. Place four inches (4") of topsoil, as required, in areas of fill and where seeding is scheduled.

C. Place two inches (2”) of topsoil, as required, in areas where seeding is to be reestablished and finish grade remains the same as prior to work.

END OF SECTION 312000

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section includes temporary excavation support and protection systems.

B. Related Requirements:

1. Section 01 32 33 "Photographic Documentation" for recording preexisting conditions and excavation support and protection system progress.
2. Section 31 20 00 "Earth Moving" for excavating and backfilling and for controlling surface-water runoff and ponding.
3. Section 31 23 19 "Dewatering" for dewatering excavations.

### 1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review existing utilities and subsurface conditions.
2. Review coordination for interruption, shutoff, capping, and continuation of utility services.
3. Review proposed excavations.
4. Review proposed equipment.
5. Review monitoring of excavation support and protection system.
6. Review coordination with waterproofing.
7. Review abandonment or removal of excavation support and protection system.

### 1.4 SUBMITTALS

A. Shop Drawings: For excavation support and protection system, prepared by or under the supervision of a qualified professional engineer.

1. Include plans, elevations, sections, and details.

2. Show arrangement, locations, and details of soldier piles, piling, lagging, tiebacks, bracing, and other components of excavation support and protection system according to engineering design.
3. Indicate type and location of waterproofing.
4. Include a written plan for excavation support and protection, including sequence of construction of support and protection coordinated with progress of excavation.

B. Qualification Data: For Installer and Professional Engineer.

C. Contractor Calculations: For excavation support and protection system. Include analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

D. Existing Conditions: Using photographs or video recordings, show existing conditions of adjacent construction and site improvements that might be misconstrued as damage caused by inadequate performance of excavation support and protection systems. Submit before Work begins.

E. Record Drawings: Identify locations and depths of capped utilities, abandoned-in-place support and protection systems, and other subsurface structural, electrical, or mechanical conditions.

## 1.5 FIELD CONDITIONS

A. Interruption of Existing Utilities: Do not interrupt any utility serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility according to requirements indicated:

1. Notify Engineer and Owner no fewer than two days in advance of proposed interruption of utility.
2. Do not proceed with interruption of utility without Owner's written permission.

B. Project-Site Information: A geotechnical report has not been prepared for this Project. Contractor shall employ a geotechnical engineer as necessary, to be approved by the owner, to render opinions and represent interpretations of subsoil conditions, tests, and results of analyses conducted by a geotechnical engineer. Owner is not responsible for interpretations or conclusions drawn from this data.

1. Make additional test borings and conduct other exploratory operations necessary for excavation support and protection according to the performance requirements.
2. The geotechnical report is included elsewhere in Project Manual.

C. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

A. Geotechnical Testing Agency: An independent testing agency qualified according to ASTM E 329 to conduct soil materials and rock-definition testing, as documented according to ASTM D 3740 and ASTM E 548.

B. Provide, design, monitor, and maintain excavation support and protection system capable of supporting excavation sidewalls and of resisting earth and hydrostatic pressures and superimposed and construction loads.

1. Contractor Design: Design excavation support and protection system, including comprehensive engineering analysis by a qualified professional engineer.
2. Prevent surface water from entering excavations by grading, dikes, or other means.
3. Install excavation support and protection systems without damaging existing buildings, structures, and site improvements adjacent to excavation.
4. Continuously monitor vibrations, settlements, and movements to ensure stability of excavations and constructed slopes and to ensure that damage to permanent structures is prevented.

### 2.2 MATERIALS

A. General: Provide materials that are either new or in serviceable condition.

B. Structural Steel: ASTM A 36, ASTM A 690, or ASTM A 992.

C. Steel Sheet Piling: ASTM A 328, ASTM A 572, or ASTM A 690; with continuous interlocks.

1. Corners: Site-fabricated mechanical interlock.

D. Wood Lagging: Lumber, mixed hardwood, nominal rough thickness of size and strength required for application.

E. Tiebacks: Steel bars, ASTM A 722.

## PART 3 - EXECUTION

### 3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards that could develop during excavation support and protection system operations.

1. Shore, support, and protect utilities encountered.

B. Install excavation support and protection systems to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner. Provide alternate routes around closed or obstructed traffic ways if required by Owner.

C. Locate excavation support and protection systems clear of permanent construction so that construction and finishing of other work is not impeded.

### 3.2 SOLDIER PILES AND LAGGING

A. Install steel soldier piles before starting excavation. Extend soldier piles below excavation grade level to depths adequate to prevent lateral movement. Space soldier piles at regular intervals not to exceed allowable flexural strength of wood lagging. Accurately align exposed faces of flanges to vary not more than 2 inches from a horizontal line and not more than 1:120 out of vertical alignment.

B. Install wood lagging within flanges of soldier piles as excavation proceeds. Trim excavation as required to install lagging. Fill voids behind lagging with soil, and compact.

C. Install wales horizontally at locations indicated on Drawings and secure to soldier piles.

### 3.3 SHEET PILING

A. Before starting excavation, install one-piece sheet piling lengths and tightly interlock vertical edges to form a continuous barrier.

B. Accurately place the piling, using templates and guide frames unless otherwise recommended in writing by the sheet piling manufacturer. Limit vertical offset of adjacent sheet piling to 60 inches Accurately align exposed faces of sheet piling

to vary not more than 2 inches from a horizontal line and not more than 1:120 out of vertical alignment.

C. Cut tops of sheet piling to uniform elevation at top of excavation.

## 3.4 TIEBACKS

A. Drill, install, grout, and tension tiebacks.

B. Test load-carrying capacity of each tieback and replace and retest deficient tiebacks.

1. Have test loading observed by a qualified professional engineer responsible for design of excavation support and protection system.

C. Maintain tiebacks in place until permanent construction is able to withstand lateral earth and hydrostatic pressures.

## 3.5 BRACING

A. Bracing: Locate bracing to clear columns, floor framing construction, and other permanent work. If necessary to move brace, install new bracing before removing original brace.

1. Do not place bracing where it will be cast into or included in permanent concrete work unless otherwise approved by Engineer.

2. Install internal bracing if required to prevent spreading or distortion of braced frames.

3. Maintain bracing until structural elements are supported by other bracing or until permanent construction is able to withstand lateral earth and hydrostatic pressures.

## 3.6 FIELD QUALITY CONTROL

A. Survey-Work Benchmarks: Resurvey benchmarks regularly during installation of excavation support and protection systems, excavation progress, and for as long as excavation remains open. Maintain an accurate log of surveyed elevations and positions for comparison with original elevations and positions. Promptly notify Engineer if changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.

B. Promptly correct detected bulges, breakage, or other evidence of movement to ensure that excavation support and protection system remains stable.

C. Promptly repair damages to adjacent facilities caused by installation or faulty performance of excavation support and protection systems.

## 3.7 REMOVAL AND REPAIRS

A. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and earth and hydrostatic pressures. Remove in stages to avoid disturbing underlying soils and rock or damaging structures, pavements, facilities, and utilities.

1. Remove excavation support and protection systems to a minimum depth of 48 inches below overlying construction and abandon remainder.

2. Fill voids immediately with approved backfill compacted to density specified in Section 31 20 00 "Earth Moving."

3. Repair or replace, as approved by Engineer, adjacent work damaged or displaced by removing excavation support and protection systems.

B. Leave excavation support and protection systems permanently in place.

END OF SECTION 315000

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. This Section includes the following:

1. Hot-mix asphalt paving.
2. Hot-mix asphalt patching.
3. Pavement-marking paint.
4. Cold milling of existing hot-mix asphalt pavement.

B. Related Sections include the following:

1. Division 01 Section Submittal Procedures" for review methods and procedures.
2. Division 02 Section "Selective Demolition" for demolition and removal of existing asphalt pavements, and for geotextiles.
3. Division 31 Section "Earth Moving" for aggregate subbase and base courses and for aggregate pavement shoulders.
4. Division 32 Section "Pavement Joint Sealants" for joint sealants and fillers at paving terminations.

### 1.3 DEFINITIONS

A. Hot-Mix Asphalt Paving Terminology: Refer to ASTM D 8 for definitions of terms.

B. DOT: Department of Transportation.

### 1.4 SYSTEM DESCRIPTION

A. Provide hot-mix asphalt paving according to materials, workmanship, and other applicable requirements of Maryland State Highway standard specifications.

1. Standard Specification: Maryland State Highway Administration Standard Specification for Construction and Materials.

2. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.

## 1.5 SUBMITTALS

A. Product Data: For each type of product indicated. Include technical data and tested physical and performance properties.

B. Job-Mix Designs: Certification, by authorities having jurisdiction, of approval of each job mix proposed for the Work.

C. Material Test Reports: For each paving material.

D. Material Certificates: For each paving material, signed by manufacturers.

## 1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: manufacturer shall be registered with and approved by Maryland State Highway Administration.

B. Testing Agency Qualifications: Qualified according to ASTM D 3666 for testing indicated, as documented according to ASTM E 548.

C. Regulatory Requirements: Comply with Maryland State Highway standard specifications for asphalt paving work.

D. Asphalt-Paving Publication: Comply with AI MS-22, "Construction of Hot Mix Asphalt Pavements," unless more stringent requirements are indicated.

## 1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver pavement-marking materials to Project site in original packages with seals unbroken and bearing manufacturer's labels containing brand name and type of material, date of manufacture, and directions for storage.

B. Store pavement-marking materials in a clean, dry, protected location within temperature range required by manufacturer. Protect stored materials from direct sunlight.

## 1.8 PROJECT CONDITIONS

A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp or if the following conditions are not met:

1. Prime and Tack Coats: Minimum surface temperature of 60 deg F.
2. Slurry Coat: Comply with weather limitations of ASTM D 3910.
3. Asphalt Base Course: Minimum surface temperature of 40 deg F and rising at time of placement.
4. Asphalt Surface Course: Minimum surface temperature of 60 deg F at time of placement.

B. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 50 deg F and not exceeding 100 deg F in a 24 hour period.

## PART 2 - PRODUCTS

### 2.1 AGGREGATES

A. General: Use materials and gradations that have performed satisfactorily in previous installations.

B. Recycled Content: Provide maximum reclaimed asphalt pavement (RAP) as feasible.

C. Regional Materials: Provide aggregate products manufactured and of primary raw materials extracted or recovered within 500 mile radius of Project Site.

D. Coarse Aggregate: In accordance with Maryland State Highway standards and specifications.

E. Fine Aggregate: In accordance with Maryland State Highway standards and specifications.

F. Mineral Filler: In accordance with Maryland State Highway standards and specifications.

### 2.2 ASPHALT MATERIALS

A. Asphalt Binder: AASHTO MP 1, PG 64-22.

B. Asphalt Cement: ASTM D 3381 for viscosity-graded material; ASTM D 946 for penetration-graded material.

C. Prime Coat: Asphalt emulsion prime complying with Maryland State Highway Administration requirements.

D. Tack Coat: ASTM D 977 or AASHTO M 140, emulsified asphalt or ASTM D 2397 or AASHTO M 208, cationic emulsified asphalt, slow setting, diluted in water, of suitable grade and consistency for application.

E. Undersealing Asphalt: ASTM D 3141 or AASHTO M 238, pumping consistency.

2.3 AUXILIARY MATERIALS

A. Herbicide: Commercial chemical for weed control, registered by the EPA. Provide in granular, liquid, or wettable powder form.

B. Paving Geotextile: AASHTO M 288, nonwoven polypropylene; resistant to chemical attack, rot, and mildew; and specifically designed for paving applications.

C. Pavement-Marking Paint: See Section 321723 “Pavement Markings”

2.4 MIXES

A. Hot-Mix Asphalt: Dense, hot-laid, hot-mix asphalt plant mixes approved by Maryland State Highway Administration; and complying with the following requirements:

1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.
2. Base Course: Superpave 19.0 mm.
3. Surface Course: Superpave 9.5 mm.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Verify that subgrade is dry and in suitable condition to support paving and imposed loads.

B. Proceed with paving only after unsatisfactory conditions have been corrected.

3.2 COLD MILLING

A. Clean existing pavement surface of loose and deleterious material immediately before cold milling. Remove existing asphalt pavement by cold milling to grades and cross sections indicated.

1. Mill to a depth of as indicated on plans.
2. Mill to a uniform finished surface free of gouges, grooves, and ridges.
3. Control rate of milling to prevent tearing of existing asphalt course.
4. Repair or replace curbs, manholes, and other construction damaged during cold milling.
5. Excavate and trim unbound-aggregate base course, if encountered, and keep material separate from milled hot-mix asphalt.
6. Transport milled hot-mix asphalt to asphalt recycling facility.
7. Keep milled pavement surface free of loose material and dust.

## 3.3 PATCHING

A. Hot-Mix Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate base course to form new subgrade.

B. Tack Coat: Apply uniformly to vertical surfaces abutting or projecting into new, hot-mix asphalt paving at a rate of 0.05 to 0.15 gal./sq. yd..

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

C. Patching: Fill excavated pavements with hot-mix asphalt base mix and, while still hot, compact flush with adjacent surfaces.

## 3.4 REPAIRS

A. Leveling Course: Install and compact leveling course consisting of hot-mix asphalt surface course to level sags and fill depressions deeper than 1 inch in existing pavements.

1. Install leveling wedges in compacted lifts not exceeding 3 inches thick.

B. Crack and Joint Filling: Remove existing joint filler material from cracks or joints to a depth of 1/4 inch.

1. Clean cracks and joints in existing hot-mix asphalt pavement.
2. Use hot-applied joint sealant to seal cracks and joints more than 1/4 inch wide. Fill flush with surface of existing pavement and remove excess.

## 3.5 SURFACE PREPARATION

A. Proof-roll subbase using heavy, pneumatic-tired rollers to locate areas that are unstable or that require further compaction.

B. Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.

1. Sweep loose granular particles from surface of unbound-aggregate base course. Do not dislodge or disturb aggregate embedded in compacted surface of base course.

C. Herbicide Treatment: Apply herbicide according to manufacturer's recommended rates and written application instructions. Apply to dry, prepared subgrade or surface of compacted-aggregate base before applying paving materials.

1. Mix herbicide with prime coat if formulated by manufacturer for that purpose.

D. Prime Coat: Apply uniformly over surface of compacted unbound-aggregate base course at a rate of 0.15 to 0.50 gal./sq. yd. Apply enough material to penetrate and seal but not flood surface. Allow prime coat to cure for 72 hours minimum.

1. If prime coat is not entirely absorbed within 24 hours after application, spread sand over surface to blot excess asphalt. Use enough sand to prevent pickup under traffic. Remove loose sand by sweeping before pavement is placed and after volatiles have evaporated.
2. Protect primed substrate from damage until ready to receive paving.

E. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd.

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

## 3.6 PAVING GEOTEXTILE INSTALLATION

A. Apply tack coat uniformly to existing pavement surfaces at a rate of 0.20 to 0.30 gal./sq. yd.

B. Place paving geotextile promptly according to manufacturer's written instructions. Broom or roll geotextile smooth and free of wrinkles and folds. Overlap longitudinal joints 4 inches and transverse joints 6 inches.

1. Protect paving geotextile from traffic and other damage and place hot-mix asphalt paving overlay the same day.

## 3.7 HOT-MIX ASPHALT PLACING

A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.

1. Spread mix at minimum temperature of 250 deg F.
2. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.

B. Place paving in consecutive strips not less than 8 feet wide unless infill edge strips of a lesser width are required.

C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

## 3.8 JOINTS

A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions with same texture and smoothness as other sections of hot-mix asphalt course.

1. Clean contact surfaces and apply tack coat to joints.
2. Offset longitudinal joints, in successive courses, a minimum of 6 inches.
3. Offset transverse joints, in successive courses, a minimum of 24 inches.
4. Construct transverse joints as described in AI MS-22, "Construction of Hot Mix Asphalt Pavements."
5. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.
6. Compact asphalt at joints to a density within 2 percent of specified course density.

## 3.9 COMPACTION

A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or vibratory-plate compactors in areas inaccessible to rollers.

1. Complete compaction before mix temperature cools to 185 deg F.

B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.

C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:

1. Average Density: 92 percent of reference maximum theoretical density according to ASTM D 2041, but not less than 90 percent nor greater than 96 percent.

D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.

E. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

F. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

## 3.10 INSTALLATION TOLERANCES

A. Thickness: Compact each course to produce the thickness indicated within the following tolerances:

1. Base Course: Plus or minus 1/2 inch.
2. Surface Course: Plus 1/4 inch, no minus.

B. Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:

1. Base Course: 1/8 inch.
2. Surface Course: 1/8 inch.

## 3.11 PAVEMENT MARKING

A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Engineer.

B. Allow paving to age for 30 days before starting pavement marking.

C. Sweep and clean surface to eliminate loose material and dust.

D. Prime asphalt surfaces with sealer, as recommended by thermoplastic material manufacturer based on surface conditions. Include adhesive or adhesion promoter when asphaltic surfaces exhibit polished aggregate.

E. Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.

1. Broadcast glass beads uniformly into wet markings at a rate of 6 lb / gal.

## 3.12 FIELD QUALITY CONTROL

A. Testing Agency: Contractor will engage a qualified independent testing and inspecting agency to perform field tests and inspections and to prepare test reports.

B. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

C. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D 3549.

D. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.

E. In-Place Density: Testing agency will take samples of uncompacted paving mixtures and compacted pavement according to ASTM D 979 or AASHTO T 168.

1. Reference maximum theoretical density will be determined by averaging results from four samples of hot-mix asphalt-paving mixture delivered daily to site, prepared according to ASTM D 2041, and compacted according to job-mix specifications.
2. In-place density of compacted pavement will be determined by testing core samples according to ASTM D 1188 or ASTM D 2726.

    a. One core sample will be taken for every 1000 sq. yd. or less of installed pavement, with no fewer than 3 cores taken.
    b. Field density of in-place compacted pavement may also be determined by nuclear method according to ASTM D 2950 and correlated with ASTM D 1188 or ASTM D 2726.

F. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

3.13 DISPOSAL

A. All excavated and demolished material shall be removed from Project site and legally dispose of them in an EPA-approved landfill.

END OF SECTION 321216

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. This Section includes exterior cement concrete pavement for the following:

1. Curbs
2. Sidewalks
3. Handicap sidewalk ramps

B. Related Sections include the following:

1. Section 033000 "Cast-in-Place Concrete" for light pole bases and other general applications of concrete.
2. Section 312000 "Earth Moving" for subgrade preparation, grading, and subbase course.
3. Section 321373 "Pavement Joint Sealants" for joint sealants of joints in concrete pavement and at isolation joints of concrete pavement with adjacent construction.

### 1.3 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash and other pozzolans, and ground granulated blast-furnace slag.

### 1.4 SUBMITTALS

A. Product Data: For each type of manufactured material and product indicated.

B. Design Mixtures: For each concrete pavement mixture. Include alternate mixture designs when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

C. Qualification Data: For manufacturer.

D. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated, based on comprehensive testing of current materials:

1. Aggregates. Include service record data indicating absence of deleterious expansion of concrete due to alkali-aggregate reactivity.

E. Material Certificates: Signed by manufacturers certifying that each of the following materials complies with requirements:

1. Cementitious materials.
2. Steel reinforcement and reinforcement accessories.
3. Admixtures.
4. Curing compounds.
5. Joint fillers.

F. Field quality-control test reports.

## 1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer of ready-mixed concrete products who complies with ASTM C 94/C 94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

B. Testing Agency Qualifications: An independent agency qualified according to ASTM C 1077 and ASTM E 329 for testing indicated, as documented according to ASTM E 548.

1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-01 or an equivalent certification program.

C. ACI Publications: Comply with ACI 301, "Specification for Structural Concrete," unless modified by requirements in the Contract Documents.

D. Concrete Testing Service: Contractor will engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.

E. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer’s plant, obtain aggregate from one source, and obtain admixtures through one source from one manufacturer.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Steel Reinforcement: Deliver, store and handle steel reinforcement to prevent bending and damage.

1.7 PROJECT CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

B. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 50 deg F and not exceeding 100 deg F in a 24 hour period.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.

2.2 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, smooth exposed surfaces.

1. Use flexible or curved forms for curves with a radius 100 feet or less.

B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

2.3 STEEL REINFORCEMENT

A. Reinforcing Steel Bars: ASTM A 615, Grade 60, deformed billet steel bars, unfinished.

1. Recycled Content: Provide steel with minimum 90 percent total recycled content, including at least 60 percent post-consumer recycled content.
2. Regional Materials: Provide steel products manufactured and of primary raw materials extracted or recovered within 500 mile radius of the Project Site.

B. Plain Steel Wire: ANSI/ASTM A82, unfinished.

C. Welded Steel Wire Fabric: ASTM A185 in flat sheets galvanized.

## 2.4 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source throughout the Project:

1. Portland Cement: ASTM C 150, Type I, white. Supplement with the following:

   a. Fly Ash: ASTM C 618, Class C.
   b. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.

B. Normal-Weight Aggregates: ASTM C 33, Class 4S coarse aggregate, uniformly graded. Provide aggregates from a single source with documented service record data of at least 10 years' satisfactory service in similar pavement applications and service conditions using similar aggregates and cementitious materials.

1. Maximum Coarse-Aggregate Size: 1-1/2 inches nominal.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
3. Regional Materials: Provide aggregate manufactured and of primary raw materials extracted or recovered within 500 mile radius of Project Site.

C. Solar Reflectance Index (SRI) of Concrete Paving: Minimum value of 29.

## 2.5 ADMIXTURES

A. Air-Entraining Admixture: ASTM C 260.

B. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.

1. Water-Reducing Admixture: ASTM C 494, Type A.
2. Retarding Admixture: ASTM C 494, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C 494, Type D.

4. High-Range, Water-Reducing Admixture: ASTM C 494, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494, Type G.
6. Plasticizing and Retarding Admixture: ASTM C 1017, Type II.

## 2.6 CURING MATERIALS

A. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

B. Water: Potable.

C. Evaporation Retarder: Waterborne, monomolecular film forming; manufactured for application to fresh concrete.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or approved equal:

a. Axim Concrete Technologies; Cimfilm.
b. Burke by Edeco; BurkeFilm.
c. ChemMasters; Spray-Film.
d. Conspec Marketing & Manufacturing Co., Inc.; Aquafilm.
e. Dayton Superior Corporation; Sure Film.
f. Euclid Chemical Company (The); Eucobar.
g. Kaufman Products, Inc.; Vapor Aid.
h. Lambert Corporation; Lambco Skin.
i. L&M Construction Chemicals, Inc.; E-Con.
j. MBT Protection and Repair, ChemRex Inc.; Confilm.
k. Meadows, W. R., Inc.; Sealtight Evapre.
l. Metalcrete Industries; Waterhold.
m. Nox-Crete Products Group, Kinsman Corporation; Monofilm.
n. Sika Corporation, Inc.; SikaFilm.
o. Symons Corporation; Finishing Aid.
p. Vexcon Chemicals, Inc.; Certi-Vex EnvioAssist.

D. Clear Waterborne Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or approved equal:

a. Anti-Hydro International, Inc.; AH Curing Compound #2 DR WB.
b. Burke by Edoko; Aqua Resin Cure.
c. ChemMasters; Safe-Cure Clear.
d. Conspec Marketing & Manufacturing Co., Inc.; W.B. Resin Cure.
e. Dayton Superior Corporation; Day Chem Rez Cure (J-11-W).

f. Euclid Chemical Company (The); Kurez DR VOX.
g. Kaufman Products, Inc.; Thinfilm 420.
h. Lambert Corporation; Aqua Kure-Clear.
i. L&M Construction Chemicals, Inc.; L&M Cure R.
j. Meadows, W. R., Inc.; 1100 Clear.
k. Nox-Crete Products Group, Kinsman Corporation; Resin Cure E.
l. Symons Corporation; Resi-Chem Clear.
m. Tamms Industries Inc.; Horncure WB 30.
n. Unitex; Hydro Cure 309.
o. Vexcon Chemicals, Inc.; Certi-Vex Enviocure 100.

## 2.7 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork.

B. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

C. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements, and as follows:

1. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

## 2.8 CONCRETE MIXTURES

A. Prepare design mixtures, proportioned according to ACI 301, for each type and strength of normal-weight concrete determined by either laboratory trial mixes or field experience.

1. Use a qualified independent testing agency for preparing and reporting proposed concrete mixture designs for the trial batch method.

B. Proportion mixtures to provide normal-weight concrete with the following properties:

1. Compressive Strength (28 Days): 3500 psi.
2. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.45.
3. Slump Limit: 4 inches, plus or minus 1 inch.

C. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:

1. Air Content: 5-1/2 percent plus or minus 1.5 percent for 1-1/2-inch nominal maximum aggregate size.
2. Air Content: 6 percent plus or minus 1.5 percent for 1-inch nominal maximum aggregate size.

D. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

E. Admixtures: Use admixtures according to manufacturer's written instructions.

1. Use water-reducing admixture in concrete, as required, for placement and workability.
2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
3. Use water-reducing admixture in pumped concrete, concrete required to be watertight and concrete with a water-cementitous materials ratio below 0.50.

F. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement according to ACI 301 requirements for concrete exposed to deicing chemicals. as follows:

1. Fly Ash or Pozzolan: 25 percent.
2. Ground Granulated Blast-Furnace Slag: 50 percent.
3. Combined Fly Ash or Pozzolan, and Ground Granulated Blast-Furnace Slag: 50 percent, with fly ash or pozzolan not exceeding 25 percent.

2.9 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M and ASTM C 1116. Furnish batch certificates for each batch discharged and used in the Work.

1. When air temperature is between 85 deg F and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

## PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.

B. Proceed with concrete pavement operations only after nonconforming conditions have been corrected and subgrade is ready to receive pavement.

## 3.2 PREPARATION

A. Remove loose material from compacted subbase surface immediately before placing concrete.

## 3.3 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides for pavement to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.

B. Construct forms tight enough to prevent loss of concrete mortar.

C. Clean forms and adjacent surfaces to receive concrete.

D. Coat contact surfaces of forms with form-release agent, according to manufacturer’s written instructions, to ensure separation from concrete without damage.

E. Clean and repair surfaces of forms to be reused in the Work.

## 3.4 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.

C. Accurately position, support and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.

D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

E. Install welded wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

3.5 JOINTS

A. General: Form construction, isolation, and contraction joints and tool edgings true to line with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline, unless otherwise indicated.

1. When joining existing pavement, place transverse joints to align with previously placed joints, unless otherwise indicated.

B. Construction Joints: Set construction joints at side and end terminations of pavement and at locations where pavement operations are stopped for more than one-half hour unless pavement terminates at isolation joints.

1. Continue steel reinforcement across construction joints, unless otherwise indicated. Do not continue reinforcement through sides of pavement strips, unless otherwise indicated.
2. Provide tie bars at sides of pavement strips where indicated.
3. Butt Joints: Use bonding agent or epoxy bonding adhesive at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
4. Keyed Joints: Provide preformed keyway-section forms or bulkhead forms with keys, unless otherwise indicated. Embed keys at least 1-1/2 inches into concrete.
5. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt-coat one-half of dowel length to prevent concrete bonding to one side of joint.

C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, walks, other fixed objects, and where indicated.

1. Locate expansion joints at intervals of 50 feet, unless otherwise indicated.
2. Extend joint fillers full width and depth of joint.
3. Terminate joint filler not less than 1/2 inch or more than 1 inch below finished surface if joint sealant is indicated.
4. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
5. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
6. Protect top edge of joint filler during concrete placement with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.

D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows to match jointing of existing adjacent concrete pavement:

1. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.

E. Edging: Tool edges of pavement, gutters, curbs, and joints in concrete after initial floating with an edging tool to a 1/4-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate tool marks on concrete surfaces.

## 3.6 CONCRETE PLACEMENT

A. Inspection: Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast in. Notify other trades to permit installation of their work.

B. Remove snow, ice, or frost from subbase surface and reinforcement before placing concrete. Do not place concrete on frozen surfaces.

C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.

D. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.

E. Do not add water to concrete during delivery or at Project site.

F. Do not add water to fresh concrete after testing.

G. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

H. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.

1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement, dowels, and joint devices.

I. Place concrete in two operations; strike off initial pour for entire width of placement and to the required depth below finish surface. Lay welded wire fabric or fabricated bar mats immediately in final position. Place top layer of concrete, strike off, and screed.

1. Remove and replace concrete that has been placed for more than 15 minutes without being covered by top layer, or use bonding agent if approved by A/E.

J. Screed pavement surfaces with a straightedge and strike off.

K. Commence initial floating using bull floats or darbies to impart an open textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

L. Slip-Form Pavers: When automatic machine placement is used for pavement, submit revised mix design and laboratory test results that meet or exceed requirements. Produce pavement to required thickness, lines, grades, finish, and jointing as required for formed pavement.

1. Compact subbase and prepare subgrade of sufficient width to prevent displacement of paver machine during operations.

M. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
2. Do not use frozen materials or materials containing ice or snow.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mix designs.

N. Hot-Weather Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:

1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

## 3.7 CONCRETE FINISHING

A. General: Do not add water to concrete surfaces during finishing operations.

B. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats, or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.

1. Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface 1/16 to 1/8 inch deep with a stiff-bristled broom, perpendicular to line of traffic.

## 3.8 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.

B. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

C. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

D. Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound as follows:

1. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

## 3.9 JOINT FILLING

A. Prepare, clean, and install joint filler according to manufacturer's written instructions.

1. Defer joint filling until concrete has aged at least one month or as recommended by manufacturer, whichever is longer. Do not fill joints until construction traffic has permanently ceased.

B. Remove dirt, debris, saw cuttings, curing compounds and sealers from joints; leave contact faces of joint clean and dry.

## 3.10 PAVEMENT TOLERANCES

A. Comply with tolerances of ACI 117 and as follows:

1. Elevation: 1/4 inch.
2. Thickness: Plus 3/8 inch, minus 1/4 inch.
3. Surface: Gap below 10-foot- long, unleveled straightedge not to exceed 1/4 inch.
4. Lateral Alignment and Spacing of Tie Bars and Dowels: 1 inch.
5. Vertical Alignment of Tie Bars and Dowels: 1/4 inch.
6. Alignment of Tie-Bar End Relative to Line Perpendicular to Pavement Edge: 1/2 inch.
7. Alignment of Dowel-Bar End Relative to Line Perpendicular to Pavement Edge: Length of dowel 1/4 inch per 12 inches.
8. Joint Spacing: 3 inches.
9. Contraction Joint Depth: Plus 1/4 inch, no minus.
10. Joint Width: Plus 1/8 inch, no minus.

## 3.11 FIELD QUALITY CONTROL

A. Testing Agency: Contractor shall engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:

1. Testing Frequency: Obtain at least 1 composite sample for each 100 cu. yd. or fraction thereof of each concrete mix placed each day.

    a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C 143; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mix. Perform additional tests when concrete consistency appears to change.
3. Air Content: ASTM C 231, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mix.

4. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each composite sample.
5. Compression Test Specimens: ASTM C 31; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
6. Compressive-Strength Tests: ASTM C 39; test 1 specimen at 7 days and 2 specimens at 28 days.

    a. A compressive-strength test shall be the average compressive strength from 2 specimens obtained from same composite sample and tested at 28 days.

C. Strength of each concrete mix will be satisfactory if average of any 3 consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.

D. Test results shall be reported in writing to A/E, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by A/E but will not be used as sole basis for approval or rejection of concrete.

F. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by A/E.

G. Remove and replace concrete pavement where test results indicate that it does not comply with specified requirements.

H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

## 3.12 REPAIRS AND PROTECTION

A. Remove and replace concrete pavement that is broken, damaged, or defective or that does not comply with requirements in this Section.

B. Drill test cores, where directed by A/E, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory pavement areas with portland cement concrete bonded to pavement with epoxy adhesive.

C. Protect concrete from damage. Exclude traffic from pavement for at least 14 days after placement. When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of materials as they occur.

D. Maintain concrete pavement free of stains, discoloration, dirt, and other foreign material. Sweep concrete pavement not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 321313

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. This Section includes the following:

1. Expansion and contraction joints within cement concrete and masonry pavement.
2. Joints between cement concrete and asphalt pavement.

B. Related Sections include the following:

1. Section 321216 "Asphalt Paving" for constructing joints between concrete and asphalt pavement.
2. Section 321313 "Concrete Paving" for constructing joints in concrete pavement.
3. Section 321400 "Unit Paving" for constructing joints in brick pavement.

### 1.3 SUBMITTALS

A. Product Data: For each joint-sealant product indicated.

B. Pavement-Joint-Sealant Schedule: Include the following information:

1. Joint-sealant application, joint location, and designation.
2. Joint-sealant manufacturer and product name.
3. Joint-sealant formulation.
4. Joint-sealant color.

C. Product Certificates: For each type of joint sealant and accessory, signed by product manufacturer.

D. Qualification Data: For Installer.

E. Compatibility and Adhesion Test Reports: From sealant manufacturer, indicating the following:

1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
2. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.

F. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for sealants.

## 1.4 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers trained and approved by manufacturer.

B. Source Limitations: Obtain each type of joint sealant through one source from a single manufacturer.

C. Preconstruction Compatibility and Adhesion Testing: Submit to joint-sealant manufacturers, for testing indicated below, samples of materials that will contact or affect joint sealants.

1. Use ASTM C 1087 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
2. Submit not fewer than three pieces of each type of material, including joint substrates, shims, joint-sealant backings, secondary seals, and miscellaneous materials.
3. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
4. For materials failing tests, obtain joint-sealant manufacturer's written instructions for corrective measures including use of specially formulated primers.

D. Product Testing: Obtain test results for "Product Test Reports" Paragraph in Division 1 "Submittal Procedures" Article from a qualified testing agency based on testing of current sealant products within a 36-month period preceding the commencement of the Work.

1. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 for testing indicated, as documented according to ASTM E 548.

## 1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site in original unopened containers or bundles with labels indicating manufacturer, product name and designation, color, expiration date, pot life, curing time, and mixing instructions for multi-component materials.

B. Store and handle materials to comply with manufacturer's written instructions to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

## 1.6 PROJECT CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F.
2. When joint substrates are wet or covered with frost.
3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products listed in other Part 2 articles.

### 2.2 MATERIALS, GENERAL

A. Compatibility: Provide joint sealants, backing materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer based on testing and field experience.

### 2.3 COLD-APPLIED JOINT SEALANTS

A. Type SL Silicone Sealant for Concrete and Asphalt: Single-component, low-modulus, neutral-curing, self-leveling silicone sealant complying with ASTM D 5893 for Type SL.

### 2.4 JOINT-SEALANT BACKER MATERIALS

A. General: Provide joint-sealant backer materials that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by joint-sealant manufacturer based on field experience and laboratory testing.

B. Round Backer Rods for Cold- and Hot-Applied Sealants: ASTM D 5249, Type 1, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.

### 2.5 PRIMERS

A. Primers: Product recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions.

B. Joint Priming: Prime joint substrates where indicated or where recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

### 3.3 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Install backer materials of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

1. Do not leave gaps between ends of backer materials.
2. Do not stretch, twist, puncture, or tear backer materials.
3. Remove absorbent backer materials that have become wet before sealant application and replace them with dry materials.

D. Install sealants using proven techniques that comply with the following and at the same time backings are installed:

1. Place sealants so they directly contact and fully wet joint substrates.
2. Completely fill recesses provided for each joint configuration.
3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

E. Tooling of Non-sag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified below

to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.

1. Remove excess sealants from surfaces adjacent to joint.
2. Use tooling agents that are approved in writing by joint-sealant manufacturer and that do not discolor sealants or adjacent surfaces.

F. Provide joint configuration to comply with joint-sealant manufacturer's written instructions, unless otherwise indicated.

G. Provide recessed joint configuration for silicone sealants of recess depth and at locations indicated.

3.4 CLEANING

A. Clean off excess sealants or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved by manufacturers of joint sealants and of products in which joints occur.

3.5 PROTECTION

A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately and replace with joint sealant so installations with repaired areas are indistinguishable from the original work.

END OF SECTION 321373

# SECTION 321400 - UNIT PAVING

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:

1. Brick pavers set in bituminous setting beds.
2. Concrete pavers set in bituminous setting beds.
3. Steel edge restraints.

B. Related Requirements:

1. Section 321216 "Asphalt Paving" for asphalt base under unit pavers.
2. Section 321313 "Concrete Paving" for concrete base under unit pavers.

### 1.3 ACTION SUBMITTALS

A. Product Data: For the following:

1. Pavers.
2. Bituminous setting materials.
3. Mortar and grout materials.
4. Edge restraints.

B. Sieve Analyses: For aggregate setting-bed materials, according to ASTM C 136.

C. Samples for Initial Selection: For each type of unit paver indicated.

D. Samples for Verification: For full-size units of each type of unit paver indicated.

### 1.4 INFORMATIONAL SUBMITTALS

A. Material Certificates: For unit pavers. Include statements of material properties indicating compliance with requirements, including compliance with standards. Provide for each type and size of unit.

## 1.5 QUALITY ASSURANCE

A. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

## 1.6 DELIVERY, STORAGE, AND HANDLING

A. Store pavers on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied.

B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

D. Store asphalt cement and other bituminous materials in tightly closed containers.

## 1.7 FIELD CONDITIONS

A. Cold-Weather Protection: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Remove and replace unit paver work damaged by frost or freezing.

B. Weather Limitations for Bituminous Setting Bed:

1. Install bituminous setting bed only when ambient temperature is above 40 deg F (4 deg C) and when base is dry.
2. Apply asphalt adhesive only when ambient temperature is above 50 deg F (10 deg C) and when temperature has not been below 35 deg F (2 deg C) for 12 hours immediately before application. Do not apply when setting bed is wet or contains excess moisture.

C. Weather Limitations for Mortar and Grout:

1. Cold-Weather Requirements: Comply with cold-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.
2. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6. Provide artificial shade and windbreaks and use cooled materials as required. Do not apply mortar to substrates with temperatures of 100 deg F (38 deg C) and higher.

a. When ambient temperature exceeds 100 deg F (38 deg C), or when wind velocity exceeds 8 mph (13 km/h) and ambient temperature exceeds 90 deg F (32 deg C), set pavers within 1 minute of spreading setting-bed mortar.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Source Limitations: Obtain each type of unit paver, joint material, and setting material from single source with resources to provide materials and products of consistent quality in appearance and physical properties.

### 2.2 BRICK PAVERS

A. Brick Pavers: Light-traffic paving brick; ASTM C 902, Class SX Type I, Application PS. Provide brick without frogs or cores in surfaces exposed to view in the completed Work.

1. Glen-Gary Corporation
2. Thickness: 2-1/4 inches (57 mm).
3. Face Size: 4 by 8 inches (102 by 203 mm).
4. Color: Rosecroft

B. Efflorescence: Brick shall be rated "not effloresced" when tested according to ASTM C 67.

### 2.3 CONCRETE PAVERS

A. Concrete Pavers: Solid paving units made from normal-weight concrete with a compressive strength not less than 6000 psi (41 MPa), water absorption not more than 5 percent according to ASTM C 140, and no breakage and not more than 1 percent mass loss when tested for freeze-thaw resistance according to ASTM C 67.

1. Hanover Architectural Products
2. Thickness: 2-1/2 inches (63 mm).
3. Face Size and Shape: 12 inches (305 mm) square.
4. Face Size and Shape: 18-by-24-inch (305-by-610-mm) rectangle.
5. Color: As selected by Owner from manufacturer's full range.

2.4 CURBS AND EDGE RESTRAINTS

A. Steel Edge Restraints: Manufacturer's standard painted steel edging 3/16 inch (4.8 mm) thick by 4 inches (100 mm) high with loops pressed from or welded to face to receive stakes at 36 inches (900 mm) o.c. and steel stakes 15 inches (380 mm) long for each loop.

1. Color: As selected by Owner from manufacturer's full range.

2.5 ACCESSORIES

A. Cork Joint Filler: Preformed strips complying with ASTM D 1752, Type II.

2.6 BITUMINOUS SETTING-BED MATERIALS

A. Primer for Base: ASTM D 2028/D 2028M, cutback asphalt, grade as recommended by unit paver manufacturer.

B. Fine Aggregate for Setting Bed: ASTM D 1073, No. 2 or No. 3.

C. Asphalt Cement: ASTM D 3381/D 3381M, Viscosity Grade AC-10 or Grade AC-20.

D. Neoprene-Modified Asphalt Adhesive: Paving manufacturer's standard adhesive consisting of oxidized asphalt combined with 2 percent neoprene and 10 percent long-fibered mineral fibers containing no asbestos.

E. Sand for Joints: Fine, sharp, washed, natural sand or crushed stone with 100 percent passing No. 16 (1.18-mm) sieve and no more than 10 percent passing No. 200 (0.075-mm) sieve.

2.7 BITUMINOUS SETTING-BED MIX

A. Mix bituminous setting-bed materials at an asphalt plant in approximate proportion, by weight, of 7 percent asphalt cement to 93 percent fine aggregate unless otherwise indicated. Heat mixture to 300 deg F (149 deg C).

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine surfaces indicated to receive unit paving, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Where unit paving is to be installed over waterproofing, examine waterproofing installation, with waterproofing Installer present, for protection from paving operations, including areas where waterproofing system is turned up or flashed against vertical surfaces.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.2 PREPARATION

A. Sweep concrete substrates to remove dirt, dust, debris, and loose particles.

## 3.3 INSTALLATION, GENERAL

A. Do not use unit pavers with chips, cracks, voids, discolorations, or other defects that might be visible or cause staining in finished work.

B. Mix pavers from several pallets or cubes, as they are placed, to produce uniform blend of colors and textures.

C. Cut unit pavers with motor-driven masonry saw equipment to provide clean, sharp, unchipped edges. Cut units to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible. Hammer cutting is not acceptable.

1. For concrete pavers, a block splitter may be used.

D. Handle protective-coated brick pavers to prevent coated surfaces from contacting backs or edges of other units. If, despite these precautions, coating does contact bonding surfaces of brick, remove coating from bonding surfaces before setting brick.

E. Joint Pattern: Running bond or Grid, as indicated on plans.

F. Tolerances: Do not exceed 1/16-inch (1.6-mm) unit-to-unit offset from flush (lippage) nor 1/8 inch in 24 inches (3 mm in 600 mm) and 1/4 inch in 10 feet (6 mm in 3 m) from level, or indicated slope, for finished surface of paving.

G. Provide edge restraints as indicated. Install edge restraints before placing unit pavers.

1. Install edge restraints to comply with manufacturer's written instructions. Install stakes at intervals required to hold edge restraints in place during and after unit paver installation.
2. For metal edge restraints with top edge exposed, drive stakes at least 1 inch (25 mm) below top edge.

## 3.4 BITUMINOUS SETTING-BED APPLICATIONS

A. Apply primer to concrete slab or binder course immediately before placing setting bed.

B. Prepare for setting-bed placement by locating 3/4-inch- (19-mm-) deep control bars approximately 11 feet (3.3 m) apart and parallel to one another, to serve as guides for striking board. Adjust bars to subgrades required for accurate setting of paving units to finished grades indicated.

C. Place bituminous setting bed where indicated, in panels, by spreading bituminous material between control bars. Spread mix at a minimum temperature of 250 deg F (121 deg C). Strike setting bed smooth, firm, even, and not less than 3/4 inch (19 mm) thick. Add fresh bituminous material to low, porous spots after each pass of striking board. After each panel is completed, advance first control bar to next position in readiness for striking adjacent panels. Carefully fill depressions that remain after removing depth-control bars.

1. Roll setting bed with power roller to a nominal depth of 3/4 inch (19 mm). Adjust thickness as necessary to allow accurate setting of unit pavers to finished grades indicated. Complete rolling before mix temperature cools to 185 deg F (85 deg C).

D. Apply neoprene-modified asphalt adhesive to cold setting bed by squeegeeing or troweling to a uniform thickness of 1/16 inch (1.6 mm). Proceed with setting of paving units only after adhesive is tacky and surface is dry to touch.

E. Place pavers carefully by hand in straight courses, maintaining accurate alignment and uniform top surface. Protect newly laid pavers with plywood panels on which workers can stand. Advance protective panels as work progresses, but maintain protection in areas subject to continued movement of materials and equipment to avoid creating depressions or disrupting alignment of pavers. If additional leveling of paving is required, and before treating joints, roll paving with power roller after sufficient heat has built up in the surface from several days of hot weather.

F. Joint Treatment: Place unit pavers with hand-tight joints. Fill joints by sweeping sand over paved surface until joints are filled. Remove excess sand after joints are filled.

## 3.5 REPAIRING, POINTING, AND CLEANING

A. Remove and replace unit pavers that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Provide new units to match adjoining units and install in same manner as original units, with same joint treatment and with no evidence of replacement.

B. Pointing: During tooling of joints, enlarge voids or holes and completely fill with grout. Point joints at sealant joints to provide a neat, uniform appearance, properly prepared for sealant application.

C. Cleaning: Remove excess grout from exposed paver surfaces; wash and scrub clean.

END OF SECTION 321400

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:

1. Welded wire grid panels, including gate panels.
2. Panel channel and angle trim.
3. Panel posts.
4. Necessary clips, straps and spacers.
5. Powdercoat finish.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for post concrete fill.
2. Section 329300, PLANTS; Furnishing and installing related plants.

### 1.3 SUBMITTALS

A. Product Data: Provide manufacturer's standard catalog details for specified products demonstrating compliance with referenced standards. Provide list of fittings being provided with descriptions and either photographs or drawings for each type.

B. Shop Drawings: Drawings shall include design layouts of the material specified including overall dimensions, heights, accessory details, methods of assembly, hardware data, milling details and foundation details. Indicate materials, methods, finishes, fittings, fasteners, anchorages, and accessory items. Submit complete shop and erection drawings for review prior to fabrication or erection. Shop drawings shall contain a certification sealed by a registered professional engineer stating that the components have been designed to the specifications provided.

C. Verification Samples: Two samples representing actual products and finishes as follows:

1. Welded wire grid panel, 6 in. x 6 in., with one edge of channel trim and one edge of angle trim, all as one unit.

2. Color Submittals: Submit metal chips, 2 in. x 3-1/2 in. minimum, showing color and texture to be provided.

D. Substitutions: If substitution of any equipment is required, submit request for approval in writing within 10 calendar days after the date of Notice to Proceed.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Fabricator of products.

B. Manufacturer: Minimum 5 years experience in manufacturing and supplying welded wire panel systems of the type required for this Project.

1.5 DELIVERY, STORAGE AND HANDLING

A. Protect materials from damage. Store panels flat. Provide edge protection when strapping is used. Do not apply loads to panel edges.

B. Inspect products upon delivery in order to submit timely freight claim for any damaged materials.

C. Store products in manufacturer's packaging until ready for installation.

D. Handle and store products according to manufacturer's recommendations. Leave products wrapped or otherwise protected and under clean and dry storage conditions until required for installation.

E. Exercise care not to scratch, mark, dent, or bend metal components during delivery, storage, and installation.

1.6 PROJECT CONDITIONS

A. Verify actual openings by field measurements before fabrication; show recorded measurements on shop drawings.

B. Coordinate field measurements and fabrication schedule with construction progress to avoid construction delays.

**PART 2 - PRODUCTS**

2.1 SUSTAINABILITY CHARACTERISTICS

A. The welded wire panel plant support system and accessories shall have completed an ISO Compliant 14040/44, third party verified Life Cycle Assessment (LCA).

2.2 ACCEPTABLE MANUFACTURER

A. **green**screen®,

1. 1743 La Cienega Blvd., Los Angeles, CA 90035; Tel: 1-800-450-3494; Fax: 310-837-0523, www.greenscreen.com.

B. Approved Equal

2.3 PANELS

A. Panels shall be rigid, three dimensional welded wire grid fabricated of 14 gage galvanized steel wire.

1. Metallic-Coated Steel Wire: Welded-wire, galvanized in accordance with ASTM A641.

B. Face Grid: Wires shall be welded at each intersection to form a 2 x 2 inch face grid on the front and back of panels,

C. Trusses: Face grids shall be separated by bent wire trusses spaced at 2-inch centers and welded to front and back face grids at each truss apex.

D. Thickness: 3 inches.

E. Length and Width: As indicated on the Drawings.

F. Tolerance: 1/8 inch in width and 1/8 inch in length.

2.4 ACCESSORIES

A. Trim:

1. Fabricate from 20-gage ASTM A879 galvanized steel.
2. Types:

a. Channel Trim: Thickness of panel x ½ inch legs.
b. Angle Trim: ½ inch x ½ inch legs.

3. Locations:

a. As indicated on the Drawings.

B. Clips and Straps: Provide manufacturer's standard types of clips and straps suitable for mounting conditions. Fabricate from ASTM A879 galvanized steel. Adjustable clips shall have ¼ inch diameter 18-8 stainless steel bolt, washer, and nut.

C. Plastic Spacers: Provide ½ inch thick black Ultra High Molecular Weight polyethylene (UHMW) washers as necessary to hold clips away from mounting surface.

D. Fence Posts: 3-inch square ASTM A500, Grade B steel tube. The steel strip used in the manufacture of the post shall conform to ASTM A1011. Minimum yield strength shall be 45,000 psi. Provide steel post caps. Overall post length shall be as indicated on the Drawings.

E. Fasteners for Mounting Clips to Fence Posts: Self drilling, self tapping hex washer head screws, with strength of Type 410 stainless steel, and corrosion resistance of Type 304 stainless steel.

F. Fasteners for Attachment to Structure Pull Out Value:

1. To Concrete or Masonry: 480 lbs.
2. To Structural Steel: 480 lbs.
3. To Light-Gage Steel Framing: 480 lbs.
4. To Wood Framing: 480 lbs.

G. Planter: See Landscape Plans for plants associated with the **green**screen® fencing.

## 2.5 SWING GATES

A. Gate Configuration: Single leaf

B. Gate Frame Height: 42 inches

C. Gate Opening Width: 42 inches

D. Steel Frames and Bracing: Fabricate members from 3-inch square ASTM A500, Grade B steel tube. The steel strip used in the manufacture of the post shall conform to ASTM A1011. Minimum yield strength shall be 45,000 psi. Provide steel post caps as necessary.

E. Hardware: Tamper resistant. Latches permitting operation from both sides of gate and hinges.

F. Finish exposed welds to comply with NOMMA Guideline 1, completely sanded joint, some undercutting and pinholes, as necessary, okay

2.6 FABRICATION

A. Cut to size.

B. Weld trim to panels and grind smooth exterior surfaces of welds.

2.7 FINISH

A. Metal components (except fasteners) shall receive commercial grade finish system after fabrication.

B. Finish System:

1. Pretreat with general purpose, alkaline, water based cleaner / degreaser applied at 240 degrees F.
2. Prime with fusion bond epoxy powder coat.
3. Topcoat with TGIC polyester or polyester-urethane powder coat with a minimum total dry film thickness of not less than 6 mils.

C. Salt Spray Resistance: Finish shall remain rust free when tested 1680 hours in accordance with ASTM B117.

D. Finish and Color: Silver.

E. Touch-Up Paint: Provide high quality, exterior-grade spray paint suitable for conditions of use.

2.8 MISCELLANEOUS MATERIALS

A. Concrete: Normal-weight, air-entrained, ready-mix concrete with a minimum 28-day compressive strength of 3000 psi (20 MPa), 3-inch (75-mm) slump, and 1-inch (25-mm) maximum aggregate size

B. Nonshrink Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M and specifically recommended by manufacturer for exterior applications.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for site clearing, earthwork, pavement work, construction layout, and other conditions affecting performance of the Work.

B. Do not begin installation before final grading is completed unless otherwise permitted by Architect.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.2 PREPARATION

A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

1. Construction layout and field engineering are specified in Section 017300 "Execution."

B. Verify alignment, support dimensions, and tolerances are correct.

C. Inventory components to ensure all required items are available for installation. Inspect components for damage. Remove damaged components from site and replace.

## 3.3 FENCE INSTALLATION - GENERAL

A. Install fences according to manufacturer's written instructions.

B. Spans: For freestanding fences and screens, span between structural supports should not exceed 8’ for 3” thick panels without thorough review of specific site conditions and mounting details. For overhead horizontal or inclined panels span between structural supports should not exceed 4’. All curved panel spans should be reviewed based on specific panel radius and center to center of proposed structural support spacing.

C. Install fences by setting posts as indicated and fastening rails and infill panels to posts. Peen threads of bolts after assembly to prevent removal.

D. Install panels plumb and square, centered within area designated for panels, and aligned to maintain modular grid.

E. Avoid cutting panels in field. Where field cutting is essential, clean and dry area and apply touch-up paint to cut edges.

F. Install securely with fasteners located to meet manufacturer’s requirements.

G. Repair bent or damaged panels. If panels cannot be repaired to satisfaction of Architect, remove from jobsite and replace with new panels.

## 3.4 INSTALLATION

A. Install welded wire panel plant support system according to manufacturer's written instructions.

B. Install welded wire panel plant support system by setting posts as indicated on the Drawings and fastening panels to posts according to manufacturer's written instructions.

C. Post: Posts to be mounted per the Drawings.

## 3.5 GATE INSTALLATION

A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

## 3.6 ADJUSTING

A. Lubricate hardware and other moving parts.

B. Remove temporary coverings and protection of adjacent work areas. Clean installed products in accordance with manufacturer's instructions before Owner's acceptance.

C. Do not use abrasive cleaners.

D. Remove from project site and legally dispose of construction debris associated with this work.

E. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

## 3.7 PROTECTION

A. Protect installed products until completion of Project.

B. Touch-up, repair or replace damaged products before Substantial Completion.

C. Protect installed products and finished surfaces from damage during construction.

D. Replace defective or damaged components as directed by Architect.

3.8 PLANT INSTALLATION

A. Refer to Section 32 93 00, PLANTS.

PART 4 - FINAL ACCEPTANCE

4.1 Final acceptance of the work by the Owner or owner’s representative will be contingent on Contractor's compliance with warranty and replacement requirements and Architect's approval.

END OF SECTION 323119

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:

1. Seeding.
2. Hydroseeding.
3. Turf renovation.

B. Related Sections:

1. Division 31 Section "Earth Moving" for excavation, filling and backfilling, and rough grading.

### 1.3 DEFINITIONS

A. Duff Layer: The surface layer of native topsoil that is composed of mostly decayed leaves, twigs, and detritus.

B. Finish Grade: Elevation of finished surface of planting soil.

C. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.

D. Planting Soil: Native or imported topsoil; manufactured topsoil, or surface topsoil modified to become topsoil; mixed with soil amendments.

E. Subgrade: Surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill before planting soil is placed.

F. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

### 1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Certification of Grass Seed: From seed vendor for each grass-seed mixture stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed.

1. Include the year of production and date of packaging

2. Certification of each seed mixture for turf grass sod, identifying source, including name and telephone number of supplier.

C. Qualification Data: For qualified landscape Installer.

D. Product Certificates: For soil amendments and fertilizers, from manufacturer.

E. Material Test Reports: For existing surface soil and imported topsoil.

F. Planting Schedule: Indicating anticipated planting dates for each type of planting.

G. Maintenance Instructions: The University will recommend procedures for maintenance of turfs during a calendar year. The Contractor shall submit a plan to conform for review and approval.

## 1.5 QUALITY ASSURANCE

A. Maryland Turf Grass Law and Regulations published by the Maryland Department of Agriculture (MDA), as amended to date.

B. Recommended Turfgrass Cultivars for Certified Sod and Professional Seed Mixtures (TT-77) published by the University of Maryland, as amended to date.

C. 2011 Maryland Standards and Specifications for Soil Erosion and Sediment Control (E&SC) published by the Maryland Department of the Environment (MDE) in association with the USDA Natural Resources Conservation Service and Maryland State Soil Conservation Committee, as amended to date.

D. Installer Qualifications: A qualified landscaping installer whose work has resulted in successful turf establishment.

1. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when planting is in progress.
2. Maintenance Proximity: Not more than two hours' normal travel time from Installer's place of business to Project site.

E. Soil-Testing Laboratory Qualifications: An independent laboratory, recognized by the Maryland Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.

F. Topsoil Analysis: Furnish soil analysis by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; sodium absorption ratio; deleterious material; pH; and mineral and plant-nutrient content of the topsoil.

1. Report suitability of tested topsoil for turf growth including testing laboratory recommended quantities of nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory topsoil.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers. Protect materials from damage and deterioration during delivery, and while stored at the project site.

B. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Accompany each delivery of bulk fertilizers and soil amendments with appropriate certificates.

1.7 PROJECT CONDITIONS

A. Planting Restrictions: Plant during planting season as indicated on approved Erosion and Sediment Control Plan. Coordinate planting periods with initial maintenance periods to provide required maintenance from date of planting completion.

B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit.

1.8 MAINTENANCE SERVICE

A. Initial Turf Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after each area is planted and continue until acceptable turf is established but for not less than the following periods:

1. Seeded Turfs: 60 days from date of Substantial Completion.

a. When initial maintenance period has not elapsed before end of planting season, or if turf is not fully established, continue maintenance during next planting season.

**PART 2 - PRODUCTS**

2.1 SEED

A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Journal of Seed Technology; Rules for Testing Seeds" for purity and germination tolerances.

B. Seed Species: Seed of grass species as follows, with not less than 95 percent germination, not less than 85 percent pure seed, and not more than 0.5 percent weed seed:

1. Blend of turf-type seed proportioned by weight as follows:

   a. 90 percent (3) varieties of Improved tall fescues
   b. 10% Kentucky Bluegrass (shamrock or Excursion)

## 2.2 INORGANIC SOIL AMENDMENTS

A. Lime: ASTM C 602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:

   1. Provide lime in form of dolomitic limestone with a minimum of 95 percent passing through No. 8 sieve and a minimum of 55 percent passing through No. 60 sieve.

B. Agricultural Gypsum: Finely ground with 90 percent passing through No. 50 sieve.

## 2.3 ORGANIC SOIL AMENDMENTS

A. Compost: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1/2-inch sieve; soluble salt content of 5 to 10 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:

   1. Organic Matter Content: 50 to 60 percent of dry weight.

B. Peat: Finely divided or of granular texture, with a pH range of 6 to 7.5, containing partially decomposed moss peat, native peat, or reed-sedge peat and having a water-absorbing capacity of 1100 to 2000 percent.

C. Use soil amendments as required to increase organic content of topsoil.

## 2.4 FERTILIZERS

A. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:

   1. Composition: 1 lb/1000 sq. ft. of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.

## 2.5 TOPSOIL

A. Topsoil: ASTM D 5268 topsoil, with pH range of 5.5 to 7, a minimum of 1.5 percent organic material content; free of stones 1 inch or larger in any dimension and other extraneous materials harmful to plant growth.

   1. Existing on-site Topsoil: Reuse suitable surface soil stockpiled on-site. Verify suitability of stockpiled surface soil to produce topsoil. Clean surface soil of

roots, plants, sod, stones, clay lumps and other extraneous materials harmful to plant growth.

a. Supplement with imported or manufactured topsoil from off-site sources when quantities are insufficient. Obtain topsoil displaced from naturally well-drained sites where topsoil occurs at least 4 inches deep; do not obtain from bogs or marshes.

2. Borrow Topsoil Source: Import topsoil or manufactured topsoil from off-site sources. Obtain topsoil displaced from naturally well-drained sites where topsoil occurs at least 4 inches deep; do not obtain from bogs or marshes.
3. Amend Existing On-Site Topsoil: Amend existing in-place surface soil to produce suitable topsoil. Verify suitability of surface soil to produce topsoil. Clean surface soil of roots, plants, sod, stones, clay lumps and other extraneous materials harmful to plant growth.

a. Surface soil may be supplemented with imported or manufactured topsoil from off-site sources when quantities are insufficient. Obtain topsoil displaced from naturally well-drained sites where topsoil occurs at least 4 inches deep; do not obtain from bogs or marshes.

2.6 MULCHES

A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.

B. Fiber Mulch: Biodegradable, dyed-wood, cellulose-fiber mulch; nontoxic; free of plant-growth or germination inhibitors; with a maximum moisture content of 15 percent and a pH range of 4.5 to 6.5.

C. Non-asphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; nontoxic and free of plant-growth or germination inhibitors.

D. Asphalt Emulsion: ASTM D 977, Grade SS-1; nontoxic and free of plant-growth or germination inhibitors.

2.7 PLANTING ACCESSORIES

A. Selective Herbicides: EPA registered and approved, of type recommended by manufacturer for application, where recommended due to on-site conditions.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine areas to be planted for compliance with requirements and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.2 PREPARATION

A. Protect structures, utilities, walkways, pavements, and other facilities, trees, shrubs, and plantings from damage caused by planting operations.

1. Protect adjacent and adjoining areas from hydro-seeding and hydro-mulching overspray.
2. Protect grade stakes set by others until directed to remove them.

B. Provide erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

## 3.3 TURF AREA PREPARATION

A. Limit turf subgrade preparation to areas to be planted.

B. Unchanged Subgrades: If turfs are to be planted in areas unaltered or undisturbed by excavating, grading, or surface-soil stripping operations, prepare surface soil as follows:

1. Remove existing grass, vegetation, and turf. Do not mix into surface soil.
2. Loosen surface soil to a depth of at least 4 inches. Apply soil amendments and fertilizers according to planting soil mix proportions and mix thoroughly into top 4 inches of soil. Till soil to a homogeneous mixture of fine texture.

    a. Apply fertilizer directly to surface soil before loosening.

3. Remove stones larger than 1 inch in any dimension and sticks, roots, trash, and other extraneous matter.
4. Legally dispose of waste material, including grass, vegetation, and turf, off Owner's property.

C. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus 1/2 inch of finish elevation. Roll and rake, remove ridges, and fill depressions to meet finish grades. Limit finish grading to areas that can be planted in the immediate future.

D. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

E. Before planting, restore planting areas if eroded or otherwise disturbed after finish grading.

## 3.4 SEEDING

A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.

1. Do not use wet seed or seed that is moldy or otherwise damaged.
2. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.

B. Sow seed at a total rate of 5 to 8 lb/1000 sq. ft.

C. Rake seed lightly into top 1/8 inch of soil, roll lightly, and water with fine spray.

D. Install straw mulch uniformly at a minimum rate of 2 tons/acre to form a uniform cover 1-1/2 inches in loose depth over seeded areas. Spread by hand, blower, or other suitable equipment.

1. Anchor straw mulch by crimping into soil with suitable mechanical equipment.
2. Bond straw mulch by spraying with asphalt emulsion at a rate of 10 to 13 gal./1000 sq. ft. Take precautions to prevent damage or staining of structures or other plantings adjacent to mulched areas. Immediately clean damaged or stained areas.

## 3.5 HYDROSEEDING

A. Hydroseeding: Mix specified seed, fertilizer, and fiber mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application.

1. Mix slurry with fiber-mulch manufacturer's recommended tackifier.
2. Apply slurry uniformly to all areas to be seeded in a one-step process. Apply slurry at a rate so that mulch component is deposited at not less than 1500-lb/acre dry weight, and seed component is deposited at not less than the specified seed-sowing rate.

## 3.6 TURF RENOVATION

A. Renovate existing turf damaged by Contractor's operations, such as storage of materials or equipment and movement of vehicles.

1. Reestablish turf where settlement or washouts occur or where minor regrading is required.
2. Provide new topsoil as required.

B. Remove sod and vegetation from diseased or unsatisfactory turf areas; do not bury in soil.

C. Remove topsoil containing foreign materials such as oil drippings, fuel spills, stones, gravel, and other construction materials resulting from Contractor's operations, and replace with new topsoil.

D. Mow, dethatch, core aerate, and rake existing turf.

E. Remove weeds before seeding. Where weeds are extensive, apply selective herbicides as required. Do not use pre-emergence herbicides.

F. Remove waste and foreign materials, including weeds, soil cores, grass, vegetation, and turf, and legally dispose of them off-site.

G. Till stripped, bare, and compacted areas thoroughly to a soil depth of 6 inches.

H. Apply soil amendments and initial fertilizers required for establishing new turfs and mix thoroughly into top 4 inches of existing soil. Install new planting soil to fill low spots and meet finish grades.

I. Apply seed and protect with straw mulch as required for new turfs.

J. Water newly planted areas and keep moist until new turf is established.

## 3.7 TURF MAINTENANCE

A. Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.

1. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.

B. Watering: Install and maintain temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of 4 inches.

1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
2. Water turf with fine spray at a minimum rate of 1 inch per week unless rainfall precipitation is adequate.

C. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than 1/3 of grass height. Remove no more than 1/3 of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:

1. Mow grass to a height of 2 to 3 inches.

D. Turf Post-fertilization: Apply fertilizer after initial mowing and when grass is dry.

1. Use fertilizer that will provide actual nitrogen of at least 1 lb/1000 sq. ft. to turf area.

## 3.8 SATISFACTORY TURFS

A. Turf installations shall meet the following criteria as determined by Engineer:

1. Satisfactory Seeded Turf: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. and bare spots not exceeding 5 by 5 inches.

B. Use specified materials to reestablish turf that does not comply with requirements and continue maintenance until turf is satisfactory.

3.9 CLEANUP AND PROTECTION

A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.

C. Remove non-degradable erosion-control measures after grass establishment period.

END OF SECTION 329200

# SECTION 329300 – PLANTS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:

1. Plants.
2. Planting soils.

B. Related Sections:

1. Section 310000 "Site Clearing" for protection of existing trees and plantings, topsoil stripping and stockpiling, and site clearing.
2. Section 312000 "Earth Moving" for excavation, filling, and rough grading and for subsurface aggregate drainage and drainage backfill materials.
3. Section 329200 "Turf and Grasses" for turf (lawn) planting, seeding, and erosion-control materials.

### 1.3 DEFINITIONS

A. Backfill: The earth used to replace or the act of replacing earth in an excavation.

B. Balled and Burlapped Stock: Plants dug with firm, natural balls of earth in which they were grown, with ball size not less than sizes indicated or diameter and depth recommended by ANSI Z60.1 for type and size of plant required; wrapped with burlap, tied, rigidly supported, and drum laced with twine with the root flare visible at the surface of the ball as recommended by ANSI Z60.1.

C. Container-Grown Stock: Healthy, vigorous, well-rooted plants grown in a container, with a well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for type and size of plant required.

D. Finish Grade: Elevation of finished surface of planting soil.

E. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.

F. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.

G. Pests: Living organisms that occur where they are not desired, or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

H. Planting Area: Areas to be planted.

I. Plant; Plants; Plant Material: These terms refer to vegetation in general, including trees, shrubs, vines, ground covers, ornamental grasses, bulbs, corms, tubers, or herbaceous vegetation.

J. Root Flare: Also called "trunk flare." The area at the base of the plant's stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.

K. Stem Girdling Roots: Roots that encircle the stems (trunks) of trees below the soil surface.

L. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

M. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

N. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil; but in disturbed areas such as urban environments, the surface soil can be subsoil.

## 1.4 SUBMITTALS

A. Product Data: For each type of product indicated, including soils.

1. Plant Materials: Include quantities, sizes, quality, and sources for plant materials.
2. Pesticides and Herbicides: Include product label and manufacturer's application instructions specific to the Project.
3. Plant Photographs: Include color photographs in digital format of each required species and size of plant material as it will be furnished to the Project. Take

photographs from an angle depicting true size and condition of the typical plant to be furnished. Include a scale rod or other measuring device in each photograph. Identify each photograph with the full scientific name of the plant, plant size, and name of the growing nursery.

B. Schedules: Submit, in writing, within 60 days of planting installation, the tentative dates for tree selection and installation.

C. Qualification Data: For qualified landscape Installer. Include list of similar projects completed by Installer demonstrating Installer's capabilities and experience. Include project names, addresses, and year completed, and include names and addresses of Owners' contact persons.

D. Product Certificates: For each type of manufactured product, from manufacturer, and complying with the following:

1. Manufacturer's certified analysis of standard products.
2. Analysis of other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.

E. Material Test Reports: For standardized ASTM D 5268 topsoil, existing native surface topsoil, existing in-place surface soil and imported or manufactured topsoil.

F. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of plants during a calendar year. Submit before start of required maintenance periods.

G. Warranty: Submit written warranty and maintenance agreement for materials as specified.

## 1.5 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape Installer whose work has resulted in successful establishment of plants.

1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
2. Experience: Three years' experience in landscape installation in addition to requirements in Division 01 Section "Quality Requirements."
3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.

4. Personnel Certifications: Installer's field supervisor assigned to the Work shall have certification in one of the following categories from the Professional Landcare Network:

    a. Certified Landscape Technician - Exterior, with installation and/or maintenance specialty area(s), designated CLT-Exterior.
    b. Certified Landscape Technician - Interior, designated CLT-Interior.
    c. Certified Ornamental Landscape Professional, designated COLP.

5. Pesticide Applicator: State licensed, commercial.

B. Soil-Testing Laboratory Qualifications: An independent or university laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.

C. Soil Analysis: For each unamended soil type, furnish soil analysis and a written report by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; sodium absorption ratio; deleterious material; pH; and mineral and plant-nutrient content of the soil.

1. Testing methods and written recommendations shall comply with USDA's Handbook No. 60.
2. The soil-testing laboratory shall oversee soil sampling; with depth, location, and number of samples to be taken per instructions from A/E. A minimum of three representative samples shall be taken from varied locations for each soil to be used or amended for planting purposes.
3. Report suitability of tested soil for plant growth.

    a. Based upon the test results, state recommendations for soil treatments and soil amendments to be incorporated. State recommendations in weight per 1000 sq. ft. or volume per cu. yd. for nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory planting soil suitable for healthy, viable plants.
    b. Report presence of problem salts, minerals, or heavy metals, including aluminum, arsenic, barium, cadmium, chromium, cobalt, lead, lithium, and vanadium. If such problem materials are present, provide additional recommendations for corrective action.

D. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1.

E. Measurements: Measure according to ANSI Z60.1. Do not prune to obtain required sizes.

1. Trees and Shrubs: Measure with branches and trunks or canes in their normal position. Take height measurements from or near the top of the root flare for

field-grown stock and container grown stock. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip to tip. Take caliper measurements 6 inches above the root flare for trees up to 4-inch caliper size, and 12 inches above the root flare for larger sizes.

2. Other Plants: Measure with stems, petioles, and foliage in their normal position.

F. Plant Material Observation: A/E may observe plant material either at place of growth or at site before planting for compliance with requirements for genus, species, variety, cultivar, size, and quality. A/E retains right to observe trees and shrubs further for size and condition of balls and root systems, pests, disease symptoms, injuries, and latent defects and to reject unsatisfactory or defective material at any time during progress of work. Remove rejected trees or shrubs immediately from Project site.

1. Notify A/E of sources of planting materials seven days in advance of delivery to site.

G. Pre-installation Conference: Conduct conference at Project site.

## 1.6 DELIVERY, STORAGE, AND HANDLING

A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of conformance with state and federal laws if applicable.

B. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Accompany each delivery of bulk fertilizers, lime, and soil amendments with appropriate certificates.

C. Do not prune trees and shrubs before delivery. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of plants during shipping and delivery. Do not drop plants during delivery and handling.

D. Handle planting stock by root ball or container.

E. Store bulbs, corms, and tubers in a dry place at 60 to 65 deg F until planting.

F. Deliver plants after preparations for planting have been completed, and install immediately. If planting is delayed more than six hours after delivery, set plants and trees in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.

1. Set balled stock on ground and cover ball with soil, peat moss, sawdust, or other acceptable material.
2. Do not remove container-grown stock from containers before time of planting.
3. Water root systems of plants stored on-site deeply and thoroughly with a fine-mist spray. Water as often as necessary to maintain root systems in a moist, but not overly-wet condition.

## 1.7 PROJECT CONDITIONS

A. Field Measurements: Verify actual grade elevations, service and utility locations, irrigation system components, and dimensions of plantings and construction contiguous with new plantings by field measurements before proceeding with planting work.

B. Interruption of Existing Services or Utilities: Do not interrupt services or utilities to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary services or utilities according to requirements indicated:

1. Notify Owner and A/E no fewer than two days in advance of proposed interruption of each service or utility.
2. Do not proceed with interruption of services or utilities without Owner's written permission.

C. Planting Restrictions: Per Section 710 Refer of the Maryland SHA Stand Specification.

D. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions and warranty requirements.

E. Coordination with Turf / Seeded Areas: Plant trees, shrubs, and other plants after finish grades are established and before planting turf / seeded areas unless otherwise indicated.

1. When planting trees, shrubs, and other plants after planting turf / seeded areas, protect these areas, and promptly repair damage caused by planting operations.

1.8 WARRANTY

A. Special Warranty: Installer agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Death and unsatisfactory growth, except for defects resulting from abuse, lack of adequate maintenance, or neglect by Owner, or incidents that are beyond Contractor's control.
b. Structural failures including plantings falling or blowing over.
c. Faulty performance of tree stabilization, edgings and tree grates.
d. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

2. Warranty Periods from Date of Planting Completion:

a. Trees, Shrubs, Vines, and Ornamental Grasses: 24 months.
b. Ground Covers, Biennials, Perennials, and Other Plants: 24 months.

3. Include the following remedial actions as a minimum:

a. Immediately remove dead plants and replace unless required to plant in the succeeding planting season.
b. Replace plants that are more than 25 percent dead or in an unhealthy condition at end of warranty period.
c. A limit of one replacement of each plant will be required except for losses or replacements due to failure to comply with requirements.
d. Provide extended warranty for period equal to original warranty period, for replaced plant material.

1.9 MAINTENANCE SERVICE

A. Initial Maintenance Service for Trees and Shrubs: Provide maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established but for not less than maintenance period below.

1. Maintenance Period: 12 months from date of planting completion.

B. Initial Maintenance Service for Ground Cover and Other Plants: Provide maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established but for not less than maintenance period below.

1. Maintenance Period: 6 months from date of planting completion.

C. Continuing Maintenance Proposal: From Installer to Owner, in the form of a standard yearly (or other period) maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.

## PART 2 - PRODUCTS

### 2.1 PLANT MATERIAL

A. General: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant Schedule or Plant Legend shown on Drawings and complying with ANSI Z60.1; and with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock, densely foliated when in leaf and free of disease, pests, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.

1. Trees with damaged, crooked, or multiple leaders; tight vertical branches where bark is squeezed between two branches or between branch and trunk ("included bark"); crossing trunks; cut-off limbs more than 3/4 inch in diameter; or with stem girdling roots will be rejected.
2. Collected Stock: Do not use plants harvested from the wild, from native stands, from an established landscape planting, or not grown in a nursery unless otherwise indicated.

B. Provide plants of sizes, grades, and ball or container sizes complying with ANSI Z60.1 for types and form of plants required. Plants of a larger size may be used if acceptable to A/E, with a proportionate increase in size of roots or balls.

C. Root-Ball Depth: Furnish trees and shrubs with root balls measured from top of root ball, which shall begin at root flare according to ANSI Z60.1. Root flare shall be visible before planting.

D. Labeling: Label at least one plant of each variety, size, and caliper with a securely attached, waterproof tag bearing legible designation of common name and full scientific name, including genus and species. Include nomenclature for hybrid, variety, or cultivar, if applicable for the plant as shown on Drawings.

E. Provide plants harvested within 500 miles of Project Site.

## 2.2 INORGANIC SOIL AMENDMENTS

A. Lime: ASTM C 602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:

1. Provide lime in form of ground dolomitic limestone.

## 2.3 FERTILIZERS

A. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:

1. Composition: 10 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.

## 2.4 PLANTING SOILS

A. Planting Soil Mix: Plant mix shall be composed of 50% existing soil and 50% amended soil mix.

1. Amended soil mix is defined as 2/3 topsoil and 1/3 pulverized pine bark (Fine Bark, or approved equal).

## 2.5 MULCHES

A. Organic Mulch: Free from deleterious materials and suitable as a top dressing of trees and shrubs, consisting of one of the following:

1. Type: Shredded hardwood bark.
2. Size Range: 3 inches maximum, 1/2 inch minimum.
3. Color: Natural.

## 2.6 WEED-CONTROL BARRIERS

A. Jute Matting: Jute fabric matting, composed of fibers formed into a stable network so that fibers retain their relative position. Fabric shall be inert to biological degradation and resist naturally-encountered chemicals, alkalis, and acids.

## 2.7 TREE STABILIZATION MATERIALS

A. Stakes and Guys:

1. Stakes and Guys are to be used for Balled and Burlapped tree only.
2. Upright and Guy Stakes: Rough-sawn, sound, new hardwood, free of knots, holes, cross grain, and other defects, 2-by-2-inch nominal by length indicated, pointed at one end.
3. Guy wire shall be No. 10 gauge galvanized steel wire, for staking of trees in at-grade conditions.
4. Rubber hose shall be ¾" black corded hose.
5. Stakes and Guys to be removed at the later of either one year or permanent stabilization of the tree.

2.8 PLANT MATERIALS

A. Plant List: Contractor shall furnish and install all plant material shown on the plans. The Plant List is provided for convenience only. The plant quantities indicated on the plans take precedence over plant lists. Contractor shall verify all quantities to their own satisfaction prior to bidding. Any discrepancies shall be reported to the Landscape Architect immediately.

B. The Contractor shall have investigated the sources of supply and satisfied themselves that they can supply all of the plants specified on the Plant List in the size, variety and quality noted before submitting their bid. Failure to take this precaution will not relive the successful bidder from their responsibility for furnishing and installing all the plant material in strict accordance with the contract requirements and without additional expense to the Owner.

C. All plants shall comply with the recommendations and requirements of ANSI 260.1 "American Standard" for Nursery Stock.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine areas to receive plants for compliance with requirements and conditions affecting installation and performance.

1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
2. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.

3. Suspend soil spreading, grading, and tilling operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
4. Uniformly moisten excessively dry soil that is not workable and which is too dusty.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by A/E and replace with new planting soil.

## 3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities and turf areas and existing plants from damage caused by planting operations.

B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil bearing water runoff or airborne dust to adjacent properties and walkways.

C. Lay out individual plant locations and areas for multiple plantings in accordance with the approved Landscape drawing. Stake locations, outline areas, adjust locations when requested, and obtain A/E's acceptance of layout before excavating or planting. Make minor adjustments as required.

D. Apply antidesiccant to trees and shrubs using power spray to provide an adequate film over trunks (before wrapping), branches, stems, twigs, and foliage to protect during digging, handling, and transportation.

1. If deciduous trees or shrubs are moved in full leaf, spray with anti-desiccant at nursery before moving and again two weeks after planting.

E. Wrap trees and shrubs with burlap fabric over trunks, branches, stems, twigs, and foliage to protect from wind and other damage during digging, handling, and transportation.

## 3.3 EXCAVATION & PLANTING

A. Refer to Section 710 of the Maryland SHA Stand Specification.

## 3.4 TREE STABILIZATION

A. Install trunk stabilization as follows unless otherwise indicated:

1. Upright Staking and Tying: Stake trees of 2- through 5-inch caliper. Stake trees of less than 2-inch caliper only as required to prevent wind tip out. Use a minimum of two stakes of length required to penetrate at least 18 inches below bottom of backfilled excavation and to extend at least 72 inches above grade. Set vertical stakes and space to avoid penetrating root balls or root masses.

2. Use two stakes for trees up to 12 feet high and 2-1/2 inches or less in caliper; three stakes for trees less than 14 feet high and up to 4 inches in caliper. Space stakes equally around trees.

3. Support trees with bands of flexible ties at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree.

4. Support trees with two strands of tie wire, connected to the brass grommets of tree-tie webbing at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree.

## 3.5 PLANT MAINTENANCE

A. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, adjusting and repairing tree-stabilization devices, resetting to proper grades or vertical position, and performing other operations as required to establish healthy, viable plantings for a period of 24 months. Spray or treat as required to keep trees and shrubs free of insects and disease.

B. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace mulch materials damaged or lost in areas of subsidence.

C. Apply treatments as required to keep plant materials, planted areas, and soils free of pests and pathogens or disease. Use integrated past management practices whenever possible to minimize the use of pesticides and reduce hazards. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.

## 3.6 PESTICIDE APPLICATION

A. Refer to Section 710 of the Maryland SHA Stand Specification.

## 3.7 CLEANUP AND PROTECTION

A. During planting, keep adjacent paving and construction clean and work area in an orderly condition.

B. Protect plants from damage due to landscape operations and operations of other contractors and trades. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.

C. After installation and before Substantial Completion, remove nursery tags, nursery stakes, tie tape, labels, wire, burlap, and other debris from plant material, planting areas, and Project site.

## 3.8 DISPOSAL

A. Remove surplus soil and waste material including excess subsoil, unsuitable soil, trash, and debris and legally dispose of them off Owner's property.

END OF SECTION 329300

# SECTION 330500 – COMMON WORK RESULTS FOR UTILITIES

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. This Section includes the following:

1. Piping joining materials.
2. Transition fittings.
3. Sleeves.
4. Identification devices.
5. Grout.
6. Flowable fill.
7. Piped utility demolition.
8. Piping system common requirements.
9. Equipment installation common requirements.
10. Painting.
11. Concrete bases.
12. Metal supports and anchorages.

### 1.3 DEFINITIONS

A. Exposed Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions.

B. Concealed Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

C. ABS: Acrylonitrile-butadiene-styrene plastic.

D. CPVC: Chlorinated polyvinyl chloride plastic.

E. PE: Polyethylene plastic.

F. PVC: Polyvinyl chloride plastic.

1.4 ACTION SUBMITTALS

A. Product Data: For the following:

1. Dielectric fittings.
2. Identification devices.

1.5 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.6 QUALITY ASSURANCE

A. Steel Support Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Steel Piping Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. Comply with ASME A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.8 COORDINATION

A. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

B. Coordinate installation of identifying devices after completing covering and painting if devices are applied to surfaces.

C. Coordinate size and location of concrete bases. Formwork, reinforcement, and concrete requirements are specified in Section 033000 "Cast-in-Place Concrete".

## PART 2 - PRODUCTS

### 2.1 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness, unless otherwise indicated.

a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

E. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

F. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

G. Solvent Cements for Joining Plastic Piping:

1. ABS Piping: ASTM D 2235.
2. CPVC Piping: ASTM F 493.
3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
4. PVC to ABS Piping Transition: ASTM D 3138.

H. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

### 2.2 TRANSITION FITTINGS

A. Transition Fittings, General: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.

B. Transition Couplings NPS 1-1/2 and Smaller:

1. Underground Piping: Manufactured piping coupling or specified piping system fitting.
2. Aboveground Piping: Specified piping system fitting.

C. AWWA Transition Couplings NPS 2 and Larger:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or approved equal:

   a. Cascade Waterworks Mfg. Co.
   b. Dresser, Inc.; DMD Div.
   c. Ford Meter Box Company, Inc. (The); Pipe Products Div.
   d. JCM Industries.
   e. Smith-Blair, Inc.
   f. Viking Johnson.

2. Description: AWWA C219, metal sleeve-type coupling for underground pressure piping.

D. Plastic-to-Metal Transition Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal:

   a. Spears Manufacturing Co.
   b. PolyCam, Inc.
   c. GF Piping Systems

2. Description: CPVC and PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint or threaded end.

E. Plastic-to-Metal Transition Unions:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or approved equal:

   a. Colonial Engineering, Inc.
   b. NIBCO INC.
   c. Spears Manufacturing Co.

2. Description: MSS SP-107 CPVC and PVC four-part union. Include brass or stainless-steel threaded end, solvent-cement-joint or threaded plastic end, rubber O-ring, and union nut.

F. Flexible Transition Couplings for Underground Nonpressure Drainage Piping:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or approved equal:

   a. Cascade Waterworks Mfg. Co.
   b. Fernco, Inc.
   c. Mission Rubber Company.
   d. Plastic Oddities.

2. Description: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.

## 2.3 SLEEVES

A. Mechanical sleeve seals for pipe penetrations are specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

B. Galvanized-Steel Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

C. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized, plain ends.

D. Cast-Iron Sleeves: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

E. Molded PVC Sleeves: Permanent, with nailing flange for attaching to wooden forms.

F. PVC Pipe Sleeves: ASTM D 1785, Schedule 40.

G. Molded PE Sleeves: Reusable, PE, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

## 2.4 IDENTIFICATION DEVICES

A. General: Products specified are for applications referenced in other utilities Sections. If more than single type is specified for listed applications, selection is Installer's option.

B. Equipment Nameplates: Metal permanently fastened to equipment with data engraved or stamped.

1. Data: Manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and essential data.
2. Location: Accessible and visible.

C. Stencils: Standard stencils prepared with letter sizes complying with recommendations in ASME A13.1. Minimum letter height is 1-1/4 inches for ducts, and 3/4 inch for access door signs and similar operational instructions.

1. Material: Fiberboard or Brass.
2. Stencil Paint: Exterior, oil-based, alkyd-gloss black enamel, unless otherwise indicated. Paint may be in pressurized spray-can form.
3. Identification Paint: Exterior, oil-based, alkyd enamel in colors according to ASME A13.1, unless otherwise indicated.

D. Snap-on Plastic Pipe Markers: Manufacturer's standard preprinted, semi-rigid, snap-on type. Include color-coding according to ASME A13.1, unless otherwise indicated.

E. Pressure-Sensitive Pipe Markers: Manufacturer's standard preprinted, color-coded, pressure-sensitive-vinyl type with permanent adhesive.

F. Pipes with OD, Including Insulation, Less Than 6 Inches: Full-band pipe markers, extending 360 degrees around pipe at each location.

G. Pipes with OD, Including Insulation, 6 Inches and Larger: Either full-band or strip-type pipe markers, at least three times letter height and of length required for label.

H. Lettering: Manufacturer's standard preprinted captions as selected by Architect.

I. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length.

1. Arrows: Either integrally with piping system service lettering to accommodate both directions of flow, or as separate unit on each pipe marker to indicate direction of flow.

J. Plastic Tape: Manufacturer's standard color-coded, pressure-sensitive, self-adhesive vinyl tape, at least 3 mils thick.

1. Width: 1-1/2 inches on pipes with OD, including insulation, less than 6 inches; 2-1/2 inches for larger pipes.
2. Color: Comply with ASME A13.1, unless otherwise indicated.

K. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch sequenced numbers. Include 5/32-inch hole for fastener.

1. Material: 0.032-inch- thick, polished brass or aluminum.
2. Material: 0.0375-inch- thick stainless steel.
3. Material: 3/32-inch- thick plastic laminate with 2 black surfaces and a white inner layer.
4. Material: Valve manufacturer's standard solid plastic.
5. Size: 1-1/2 inches in diameter, unless otherwise indicated.
6. Shape: As indicated for each piping system.

L. Valve Tag Fasteners: Brass, wire-link or beaded chain; or brass S-hooks.

M. Engraved Plastic-Laminate Signs: ASTM D 709, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white melamine subcore, unless otherwise indicated. Fabricate in sizes required for message. Provide holes for mechanical fastening.

1. Engraving: Engraver's standard letter style, of sizes and with terms to match equipment identification.
2. Thickness: 1/8 inch, unless otherwise indicated.
3. Thickness: 1/16 inch, for units up to 20 sq. in. or 8 inches in length, and 1/8 inch for larger units.
4. Fasteners: Self-tapping, stainless-steel screws or contact-type permanent adhesive.

N. Plastic Equipment Markers: Manufacturer's standard laminated plastic, in the following color codes:

1. Green: Cooling equipment and components.
2. Yellow: Heating equipment and components.
3. Brown: Energy reclamation equipment and components.
4. Blue: Equipment and components that do not meet criteria above.
5. Hazardous Equipment: Use colors and designs recommended by ASME A13.1.
6. Terminology: Match schedules as closely as possible. Include the following:

    a. Name and plan number.
    b. Equipment service.
    c. Design capacity.
    d. Other design parameters such as pressure drop, entering and leaving conditions, and speed.

7. Size: 2-1/2 by 4 inches for control devices, dampers, and valves; 4-1/2 by 6 inches for equipment.

O. Plasticized Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with mat finish suitable for writing.

1. Size: 3-1/4 by 5-5/8 inches.
2. Fasteners: Brass grommets and wire.
3. Nomenclature: Large-size primary caption such as DANGER, CAUTION, or DO NOT OPERATE.

P. Lettering and Graphics: Coordinate names, abbreviations, and other designations used in piped utility identification with corresponding designations indicated. Use numbers, letters, and terms indicated for proper identification, operation, and maintenance of piped utility systems and equipment.

1. Multiple Systems: Identify individual system number and service if multiple systems of same name are indicated.

2.5 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

1. Characteristics: Post hardening, volume adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

2.6 FLOWABLE FILL

A. Description: Low-strength-concrete, flowable-slurry mix.

1. Cement: ASTM C 150, Type I, portland.
2. Density: 115- to 145-lb/cu. ft.
3. Aggregates: ASTM C 33, natural sand, fine and crushed gravel or stone, coarse.
4. Aggregates: ASTM C 33, natural sand, fine.
5. Admixture: ASTM C 618, fly-ash mineral.
6. Water: Comply with ASTM C 94/C 94M.
7. Strength: 100 to 200 psig at 28 days.

**PART 3 - EXECUTION**

3.1 PIPED UTILITY DEMOLITION

A. Refer to Section 024119 "Selective Demolition" for general demolition requirements and procedures.

B. Disconnect, demolish, and remove piped utility systems, equipment, and components indicated to be removed.

1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
2. Piping to Be Abandoned in Place: Drain piping. Fill abandoned piping with flowable fill, and cap or plug piping with same or compatible piping material.
3. Equipment to Be Removed: Disconnect and cap services and remove equipment.
4. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make operational.

5. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

## 3.2 PIPING INSTALLATION

A. Install piping according to the following requirements and utilities Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on the Coordination Drawings.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping to permit valve servicing.

E. Install piping at indicated slopes.

F. Install piping free of sags and bends.

G. Install fittings for changes in direction and branch connections.

H. Select system components with pressure rating equal to or greater than system operating pressure.

I. Sleeves are not required for core-drilled holes.

J. Permanent sleeves are not required for holes formed by removable PE sleeves.

K. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.

1. Cut sleeves to length for mounting flush with both surfaces.

    a. Exception: Extend sleeves installed in floors of equipment areas or other wet areas 2 inches above finished floor level.

2. Install sleeves in new walls and slabs as new walls and slabs are constructed.

    a. Steel Pipe Sleeves: For pipes smaller than NPS 6.

b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.

L. Verify final equipment locations for roughing-in.

M. Refer to equipment specifications in other Sections for roughing-in requirements.

## 3.3 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and utility Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

E. Welded Joints: Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

F. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

G. Grooved Joints: Assemble joints with grooved-end pipe coupling with coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.

H. Soldered Joints: Apply ASTM B 813 water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy (0.20 percent maximum lead content) complying with ASTM B 32.

I. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

J. Pressure-Sealed Joints: Assemble joints for plain-end copper tube and mechanical pressure seal fitting with proprietary crimping tool to according to fitting manufacturer's written instructions.

K. Plastic Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 appendixes.
3. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
4. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
5. PVC Nonpressure Piping: Join according to ASTM D 2855.
6. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D 3138 Appendix.

L. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.

M. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.

N. Plastic Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.

1. Plain-End PE Pipe and Fittings: Use butt fusion.
2. Plain-End PE Pipe and Socket Fittings: Use socket fusion.

O. Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

## 3.4 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
3. Install dielectric fittings at connections of dissimilar metal pipes.

## 3.5 EQUIPMENT INSTALLATION

A. Install equipment level and plumb, unless otherwise indicated.

B. Install equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference with other installations. Extend grease fittings to an accessible location.

C. Install equipment to allow right of way to piping systems installed at required slope.

## 3.6 IDENTIFICATION

A. Piping Systems: Install pipe markers on each system. Include arrows showing normal direction of flow.

1. Stenciled Markers: According to ASME A13.1.
2. Locate pipe markers on exposed piping according to the following:

    a. Near each valve and control device.
    b. Near each branch, excluding short takeoffs for equipment and terminal units. Mark each pipe at branch if flow pattern is not obvious.
    c. Near locations where pipes pass through walls or floors or enter inaccessible enclosures.
    d. At manholes and similar access points that permit view of concealed piping.
    e. Near major equipment items and other points of origination and termination.

B. Equipment: Install engraved plastic-laminate sign or equipment marker on or near each major item of equipment.

1. Lettering Size: Minimum 1/4 inch high for name of unit if viewing distance is less than 24 inches, 1/2 inch high for distances up to 72 inches, and proportionately larger lettering for greater distances. Provide secondary lettering two-thirds to three-fourths of size of principal lettering.
2. Text of Signs: Provide name of identified unit. Include text to distinguish among multiple units, inform user of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.

C. Adjusting: Relocate identifying devices that become visually blocked by work of this or other Divisions.

## 3.7 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.

1. Related specifications:

    a. Section 033000 – Cast-in-Place Concrete

2. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
3. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of base.
4. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
5. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
6. Install anchor bolts to elevations required for proper attachment to supported equipment.
7. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
8. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Section 033000 "Cast-in-Place Concrete."

## 3.8 GROUTING

A. Mix and install grout for equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

END OF SECTION 330500

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:

1. Precast Structures.
2. Utility Structure Accessories.

### 1.3 SUBMITTALS

A. Product Data: For the following:

1. Accessories for structures.

B. Shop Drawings for Precast or Factory-Fabricated Underground Utility Structures: Include plans, elevations, sections, details, attachments to other work, and accessories, including the following:

1. Reinforcement details.
2. Frame and cover design and structure frame support rings.
3. Ladder details.
4. Grounding details.
5. Dimensioned locations and sizes of all openings and sumps.
6. Joint details.

C. Product Certificates: For concrete and steel used in precast concrete structures, comply with ASTM C 858.

D. Qualification Data: For qualified professional engineer and testing agency.

E. Source quality-control reports.

F. Field quality-control reports.

### 1.4 QUALITY ASSURANCE

A. Comply with IEEE C2.

B. Comply with NFPA 70.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store precast concrete underground utility structures at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.

B. Lift and support precast concrete units only at designated lifting or supporting points.

1.6 COORDINATION

A. Coordinate layout and installation of structures with final arrangement of other utilities, site grading, and surface features as determined in the field.

B. Coordinate elevations of pipe and conduit entrances into structures with final locations and profiles of those utilities as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations from those indicated as required to suit field conditions and to ensure that pipe and conduit runs drain to structures, and as approved by Architect.

**PART 2 - PRODUCTS**

2.1 PRECAST STRUCTURES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or approved equal::

1. Christy Concrete Products.
2. Cretex Concrete Products West, Inc.; Riverton Division.
3. Oldcastle Precast Group.
4. Oldcastle Precast Inc.; Utility Vault Division.
5. Utility Concrete Products, LLC.

B. Comply with ASTM C 858, with structural design loading as specified on the drawings, and with interlocking mating sections, complete with accessories, hardware, and features.

1. Openings: Precast openings in walls, arranged to match dimensions and elevations of approaching pipes and conduits with the manufacturer's standard allowance, vertically and horizontally, to accommodate alignment variations.

a. Openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.

C. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

## 2.2 UTILITY STRUCTURE ACCESSORIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or approved equal::

1. Bilco Company (The).
2. Campbell Foundry Company.
3. McKinley Iron Works.
4. Neenah Foundry Company.
5. Oldcastle Precast Group.
6. Oldcastle Precast Inc.; Utility Vault Division.

B. Ferrous metal hardware, where indicated, shall be hot-dip galvanized complying with ASTM A 153 and A 123.

C. Structure Frames, Covers, and Chimney Components: Comply with structural design loading specified for structure.

1. Frame and Cover: Weatherproof, gray cast iron complying with ASTM A 48/A 48M, Class 30B with milled cover-to-frame bearing surfaces; diameter as indicated on the drawings.

    a. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

2. Cover Legend: Cast in. Retained to suit system.
3. Structure Chimney Components: Precast concrete rings with dimensions matched to those of roof opening.

    a. Mortar for Chimney Ring and Frame and Cover Joints: Comply with ASTM C 270, Type M, except for quantities less than 2.0 cu. ft. where packaged mix complying with ASTM C 387/C 387M, Type M, may be used.

D. Expansion Anchors for Installation after Concrete Is Cast: Zinc-plated, carbon-steel-wedge type with stainless-steel expander clip with 1/2-inch bolt, 5300-lbf rated pullout strength, and minimum 6800-lbf rated shear strength.

E. Sealing Compound: Non-hardening, safe for contact with human skin, and workable at temperatures as low as 35 deg F. Capable of withstanding temperature of 300 deg F without slump and adhering to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.

F. Fixed Structure Ladders: Arranged for attachment to wall and floor of structure. Ladder and mounting brackets and braces shall be fabricated from hot-dip galvanized steel.

G. Cover Hooks: Heavy duty, designed for lifts 60 lbf required.

2.3 SOURCE QUALITY CONTROL

A. Test and inspect precast concrete utility structures according to ASTM C 1037.

**PART 3 - EXECUTION**

3.1 CORROSION PROTECTION

A. Aluminum shall not be installed in contact with earth or concrete.

3.2 UNDERGROUND ENCLOSURE APPLICATION

A. Structures: Precast concrete.

1. Units Located in Roadways and Other Deliberate Traffic Paths by Heavy or Medium Vehicles: H-20 structural load rating according to AASHTO HB 17.
2. Units Not Located in Deliberate Traffic Paths by Heavy or Medium Vehicles: H-10 load rating according to AASHTO HB 17.

3.3 EARTHWORK

A. Excavation and Backfill: Comply with Division 31 Section "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.

B. Restore surface features at areas disturbed by excavation and reestablish original grades unless otherwise indicated. Replace removed sod immediately after backfilling is completed.

C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Division 32 Sections "Turfs and Grasses" and "Plants."

D. Cut and patch existing pavement in the path of underground ducts and utility structures according to Division 1 Section "Cutting and Patching".

## 3.4 INSTALLATION OF CONCRETE STRUCTURES

A. Precast Concrete Handhole and Structure Installation:

1. Comply with ASTM C 891 unless otherwise indicated.
2. Install units level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.
3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

B. Elevations:

1. Structure Roof: Install with rooftop at least 15 inches below finished grade.
2. Structure Frame: In paved areas and trafficways, set frames flush with finished grade. Set other structure frames 1 inch above finished grade.

C. Drainage: Install drains in bottom of structures where indicated. Coordinate with drainage provisions indicated.

D. Structure Access: Circular opening in structure roof; sized to match cover size.

1. Structures with Fixed Ladders: Offset access opening from structure centerlines to align with ladder.
2. Install chimney, constructed of precast concrete collars and rings to support frame and cover and to connect cover with structure roof opening. Provide moisture-tight masonry joints and waterproof grouting for cast-iron frame to chimney.

E. Fixed Structure Ladders: Arrange to provide for safe entry with maximum clearance from other items in structures.

F. Field-Installed Bolting Anchors in Structures: Do not drill deeper than 3-7/8 inches for anchor bolts installed in the field.

G. Warning Sign: Install "Confined Space Hazard" warning sign on the inside surface of each structure cover.

## 3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Demonstrate capability and compliance with requirements on completion of installation of underground utility structures.
2. Test structure grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Division 16 Section "Grounding and Bonding."

B. Correct deficiencies and retest as specified above to demonstrate compliance.

C. Prepare test and inspection reports.

3.6 CLEANING

A. Clean internal surfaces of structures, including sump. Remove foreign material.

END OF SECTION 330510

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:

1. Pipe and fittings.
2. Non-pressure transition couplings.

B. Related Sections include the following:

1. Division 01 “Temporary Facilities” for temporary utilities, temporary construction and support facilities, temporary security and protection facilities, and temporary erosion and sedimentation control procedures.
2. Division 01 “Project Record Documents” for preparation of record documents identifying and accurately locating final storm drainage infrastructure.
3. Division 31 “Earth Moving” for soil materials, excavating, backfilling, and site grading.

### 1.3 DEFINITIONS

A. PVC: Polyvinyl Chloride

B. HDPE: High Density Polyethylene

C. RCP: Reinforced Concrete Pipe

D. DIP: Ductile Iron Pipe

### 1.4 PERFORMANCE REQUIREMENTS

A. Gravity-Flow, Non-pressure, Drainage-Piping Pressure Rating: At least equal to system test pressure. Pipe joints shall be water tight.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Product Certificates: For each type of pipe and fitting, from manufacturer.

C. Field quality-control reports.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic pipe and fittings in direct sunlight.

B. Protect pipe, pipe fittings, and seals from dirt and damage.

1.7 PROJECT CONDITIONS

A. Interruption of Existing Storm Drainage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Engineer and Owner no fewer than two days in advance of proposed interruption of service.
2. Do not proceed with interruption of service without Owner's written permission.

**PART 2 - PRODUCTS**

2.1 DUCTILE-IRON, CULVERT PIPE AND FITTINGS

A. Pipe: ASTM A 716, for push-on joints.

B. Standard Fittings: AWWA C110, ductile or gray iron, for push-on joints.

C. Compact Fittings: AWWA C153, for push-on joints.

D. Gaskets: AWWA C111, rubber.

2.2 NONPRESSURE TRANSITION COUPLINGS

A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground non-pressure piping. Include ends of same

sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.

B. Sleeve Materials:

1. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.

## 2.3 HIGH DENSITY POLYETHYLENE PIPE AND FITTINGS

A. HDPE Pipe and Fittings, NPS 6 and Larger: Corrugated and smooth lined pipe and fittings manufactured in accordance with requirements of ASTM F 2306, latest edition. Pipe shall be type S with a full circular cross section, with an outer corrugated pipe wall and a smooth inner wall. Fittings shall be water-tight.

B. HDPE corrugated and smooth lined pipe shall be manufactured from virgin PE compounds which conform to the requirements of cell classification 335444C as defined and described in ASTM D 3350.

C. Minimum pipe stiffness at five percent deflection shall be as described in ASTM F 2306, Section 6.3 when tested in accordance with ASTM D 2412.

D. HDPE pipe and fittings shall be supplied by the same Manufacturer. Pipe and fittings from different Manufacturers shall not be mixed.

## 2.4 CONCRETE

A. General: Cast-in-place concrete according to ACI 318, ACI 350/350R, and the following:

1. Cement: ASTM C 150, Type II.
2. Fine Aggregate: ASTM C 33, sand.
3. Coarse Aggregate: ASTM C 33, crushed gravel.
4. Water: Potable.

B. Portland Cement Design Mix: 3500 psi minimum, with 0.45 maximum water/cementitious materials ratio.

1. Reinforcing Fabric: ASTM A 185, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A 615, Grade 60 deformed steel.

## PART 3 - EXECUTION

### 3.1 EARTHWORK

A. Excavation, trenching, and backfilling are specified in Section 312000 "Earth Moving."

### 3.2 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.

C. Install gravity-flow, non-pressure drainage piping according to the following:

1. Install piping pitched down in direction of flow.
2. Install piping NPS 6 and larger with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place concrete supports or anchors.
3. Install piping with 36-inch minimum cover, unless noted otherwise on the plans.
4. Install PVC water-service piping according to ASTM D 2321 and ASTM F 1668.

### 3.3 PIPE JOINT CONSTRUCTION

A. Join gravity-flow, non-pressure drainage piping according to the following:

1. Join PVC cellular-core piping according to ASTM D 2321 and ASTM F 891 for solvent-cemented joints.

### 3.4 CONCRETE PLACEMENT

A. Place cast-in-place concrete according to ACI 318.

## 3.5 CONNECTIONS

A. Connect non-pressure, gravity-flow drainage piping in building's storm drains specified in Division 15.

B. Make connections to existing piping and underground manholes.

1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye fitting, plus 6-inch overlap, with not less than 6 inches of concrete with 28-day compressive strength of 3500 psi.
2. Make branch connections from side into existing piping, NPS 4 to NPS 20. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than 6 inches of concrete with 28-day compressive strength of 3500 psi.
3. Protect existing piping, manholes, and structures to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

C. Pipe couplings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

## 3.6 IDENTIFICATION

A. Materials and their installation are specified in Section 31 20 00 "Earth Moving." Arrange for installation of green warning tape directly over piping and at outside edge of underground structures.

1. Use detectable warning tape over nonferrous piping.

## 3.7 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.

1. Submit separate reports for each system inspection.
2. Defects requiring correction include the following:

a. Alignment: Less than full diameter of inside of pipe is visible between structures.
b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
d. Infiltration: Water leakage into piping.

e. Exfiltration: Water leakage from or around piping.

3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
4. Reinspect and repeat procedure until results are satisfactory.

B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.

1. Do not enclose, cover, or put into service before inspection and approval.
2. Test completed piping systems according to requirements of UMB.
3. Schedule tests and inspections by the Owner with at least 24 hours' advance notice.
4. Submit separate report for each test.
5. Gravity-Flow Storm Drainage Piping: Test according to requirements of UMB and the following:

a. Exception: Piping with soil-tight joints unless required by the Owner.
b. Test plastic piping according to ASTM F 1417.

C. Leaks and loss in test pressure constitute defects that must be repaired.

D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

## 3.8 CLEANING

A. Clean interior of piping of dirt and superfluous materials. Flush with water.

END OF SECTION 334100

**SECTION 336313 – STEAM PIPING (VEOLIA)**

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 DESCRIPTION OF WORK

A. All underground steam lines, as indicated on contract drawings, shall be Class A testable, drainable and dryable. The system supplier shall have fabricated systems of the composition herein for at least three years. All straight sections, fittings, anchors, and other accessories shall be factory prefabricated to job dimensions and designed to minimize the number of field welds. Each system layout shall be computer analyzed by the piping system manufacturer to determine the stresses on the carrier pipe and anticipated thermal movement of the service pipe. The system design shall be in strict conformance with ASME B31.1, latest edition. Factory trained field technical assistance shall be provided for the critical periods of installation, i.e., unloading, field joint instruction and testing. The preapproved conduit system shall include all piping and components to a point twelve inches inside the building, or manhole wall. Manufacturer shall be Rovanco (Insul 800 Elite).
   1. In addition, supply the following:
      a. 20 LF of straight, factory-fabricated, pre-insulated pipe in all sizes indicated on contract drawings for field modifications.
      b. 4 spare factory supplied field closure kits in all pipe sizes indicated on contract drawings.

B. The system supplier's representative shall be responsible for directing the installation and testing of the conduit system, including training the installing contractor, overseeing the installation process, and reviewing manufacturer’s installation instructions with the Contractor and Owner’s inspectors. Submit the factory representative’s resume for approval by the Owner. Where the manufacturer’s warranty requires the factory representative to be on site during all phases of construction, that factory representative shall be assigned for the duration of the project. Where the manufacturer’s warranty does not require 100% factory representative on-site at all times, this specification is not requiring 100% on-site at all times. The Contractor is responsible for compliance with manufacturer’s instructions. The Owner and Engineer may inspect the installation as clarified below but neither party has responsibility for the installation or quality control measures for the warranty. It shall be certified in writing by the supplier that the factory representative is technically qualified and has a minimum of 5 years’ experience in the design and/or inspection of the systems. Where required by the warranty, the supplier's representative shall be present 100% of the time during the work phases listed below to approve the contractor’s methods, otherwise, inspections will be performed as follows (but the clarifications have no bearing on warranty):
   1. Inspection and unloading: At a minimum, regardless of warranty requirement by the manufacturer, the factory representative shall witness the first unloading procedure. At this first trip, the factory representative shall review the manufacturer’s instructions with the Owner, Contractor, and Engineer.
   2. Inspection of trench prior to laying of conduit: At a minimum, regardless of warranty

requirements, the factory representative shall inspect the first set up. If 100% on-site is not required for warranty, the Owner may perform inspections with spot inspections by the Engineer.

3. Inspection of expansion loops: If 100% on-site factory representative is not required by warranty, the Owner and Engineer may perform inspections.
4. Inspection of joining of system: At a minimum, regardless of the manufacturer's warranty requirement for the on-site factory representative, the factory representative shall witness the first joint closure procedure. If 100% on-site is not required for warranty, the Owner may witness all subsequent pipe joining work.
5. Hydrostatic Testing (piping): Regardless of manufacturer's warranty requirements for the on-site factory representative, the Owner will witness.
6. Air test (conduit): Regardless of manufacturer's warranty requirements for the on-site factory representative, the Owner will witness.
7. Repair of any patchwork: At a minimum, regardless of warranty requirements, the factory representative shall inspect the first repair. If 100% on-site is not required for warranty, the Owner may perform inspections with spot inspections by the Engineer.
8. Back filling of conduit sections: If 100% on-site factory representative is not required by warranty, the Owner and Engineer may perform inspections.

C. The Piping Installation Contractor shall not perform any of the above stated work in the absence of the Piping Supplier's representative. Where 100% on-site attendance is not required by the Piping Supplier's representative, the Piping Installation Contractor shall not perform any of the above stated work in the absence of the Owner's inspector.

D. The Piping Supplier's representative shall prepare and daily submit field reports for each of the inspections and tests witnessed above. Field reports shall be submitted daily to the Owner and Engineer.

E. The Piping Installation Contractor performing the work shall be responsible for the installation of the preapproved system and all other components of the underground steam and condensate conduit systems, including the piping and equipment in the manholes and buildings. This responsibility shall include all site work and purchase of the preapproved system from the system supplier.

1.3 SUBMITTALS

A. Refer to Division 1 and Basic Mechanical Requirements for administrative and procedural requirements for submittals.

B. Product Data: Submit manufacturer's technical product data, including installation instructions, and dimensioned drawings for the type of manufactured piping specialty.

C. Shop Drawings: Submit for fabricated specialties, indicating details of fabrication, materials, and method of support. A complete engineering stress analysis indicating all anchors, fittings, dimensions in three axes, maximum anticipated stresses and maximum allowable stresses must be submitted.

D. Piping Supplier shall submit factory prepared and certified Underground Piping System layout drawings at same scale as Contract Drawings.

E. Piping Supplier shall submit factory prepared and certified Underground Piping System stress and thermal movement calculations for carrier pipe.

F. Piping Supplier shall submit anchor details and calculations.

G. Maintenance Data: Submit maintenance data and spare parts lists for each type of manufactured piping specialty. Include this data, product data, and shop drawings in maintenance manual; in accordance with requirements of Division 1.

H. Quality Control Submittals:
1. Submit certified factory test results for insulation testing prior to shipment.
2. Technical qualification certification of the supplier's on-site representative.
3. Welding procedures: Shall include QW-482 "Suggested Format for Welding Procedure Specification (WPS)" and QW-483 "Suggested Format for Procedure Qualification Record (PQR)" as specified in Welding Quality Assurance below for different weld types.
4. Welders' Certificates: Shall include QW-484 "Suggested Format for Manufacturer's Record of Welder or Welding Operator Qualification Tests (WPQ)" for all welders for all weld types as specified in Welding Quality Assurance below.
5. Welder Identification List

I. Excavation Support and Protection:
1. Prior to starting work, submit for review and approval, calculations and shop drawings showing each proposed method of supporting adjacent earth and structures; i.e. retention system and other methods of bracing. Include the following:
a. Lists of material to be used, including design mixes.
b. Sequence of operations.
c. Detailed sections clearly illustrating the scope of work.
d. Relationship of piles, lagging, walls, and bracing to new and existing structures.
e. Location of utilities and details of support when required.
f. Procedures and details of testing.
2. Shop drawings and calculations: Prepared by qualified Licensed Professional Engineers registered in the State of Florida and bearing their seals and signatures.
3. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of complete projects with project names and addresses, names and addresses of architects and owners, and other information specified.

J. All piping, fittings, and accessories shall be provided by a single manufacturer.

K. Photographs or videotape, sufficiently detailed, of existing conditions of adjoining construction and site improvements that might be misconstrued as damage caused by excavation support and protection systems.

1.4 QUALITY ASSURANCE

A. Codes and Standards:
1. All piping systems with the exception of potable city water, sanitary, and other plumbing

systems piping shall be designed, fabricated, erected, and tested in accordance with ASME B31.1.

2. All welders performing welding to this procedure shall be qualified to this procedure in accordance with ASME Boiler and Pressure Vessel Code, Section IX, "Welding and Brazing Qualifications."
3. Conform to ASME Boiler and Pressure Vessel Code and ASME B31.1 Power Piping Code for administrative and technical requirements for Boiler External Piping and Nonboiler External Piping.
4. Comply with the latest editions of the publications of the following Agencies to the extent referenced in this Section:
   a. ANSI - American National Standards Institute.
   b. API - American Petroleum Institute.
   c. ASME - American Society of Mechanical Engineers.
   d. ASTM - American Society for Testing and Materials.
   e. AWS - American Welding Society.
   f. AWWA - American Water Works Association.
   g. CISPI - Cast Iron Soil Pipe Institute Association.
   h. FM - Factory Mutual.
   i. NFPA - National Fire Protection Association.
   j. PFI - Pipe Fabrication Institute.
   k. UL - Underwriter's Laboratories, Inc.

B. Special Precautions
   1. Torch cutting will be permitted only with the specific written approval of the Utilities. Any cutting method, which may create sparks, must include "Fire Watch". Submit "Fire Watch" procedure for approval.
   2. Draining operations must not damage building components or endanger human health.

C. Country of Fabrication:
   1. All piping, fittings, and piping accessories not manufactured, fabricated, and/or assembled in the United States of America or Canada must be manufactured, fabricated, and/or assembled by an ISO 9001 registered corporation.
   2. Submit ISO 9001 registration certificates for all corporations where the piping, fittings, and piping accessories are not manufactured, fabricated, and/or assembled in the United States or Canada.
   3. For all piping, fittings, and piping accessories not fabricated in the United States or Canada, submit an independent test report for all materials to be provided.
   4. No piping, fittings, and piping accessories manufactured, fabricated, and/or assembled in China including Taiwan are permitted to be provided in this Contract.

1.5 WELDING QUALITY ASSURANCE

A. Welding Procedures: In the form of a submittal, the Contractor shall record in detail and shall qualify the Welding Procedure Specifications for every welding procedure that he proposes. Procedures shall be developed for all metals included in the work. The procedures for making transition welds between different materials or between plates or pipes of different wall thickness shall be qualified. Qualification for each welding procedure shall conform to the requirements of ASME B31.1, and to this specification. The method for each system shall be fully described including the number of beads, the volts, the amperes, and the welding rod for various pipe

thicknesses and materials. The welding procedures shall specify end preparation for butt welds including cleaning, alignment, and root openings. Preheat, interpass temperature control, and postheat treatment of welds shall be as required by approved welding procedures, unless otherwise indicated or specified. Approval of any procedure does not relieve the Contractor of the sole responsibility for producing acceptable welds. Welding procedures shall be identified individually and shall be clearly referenced to the type of welding required for this project. These procedures shall be the same as those used for all pipe welder qualification tests, all shop welds, and all field welds. The Contractor shall provide Procedure Qualification Records for all proposed Welding Procedure Specifications (WPS).

B. Welding Procedure Submittals: Submit the following:
   1. Welding Procedure Specifications: Provide for each weld type. It is highly recommended that the Contractor use ASME Form E00006, QW-482 "Suggested Format for Welding Procedure Specification (WPS)".
   2. Procedure Qualification Records: Provide for each weld type. It is highly recommended that the Contractor use ASME Form E00007, QW-483 "Suggested Format for Procedure Qualification Record (PQR)".

C. Welder Qualification:
   1. WPQs: Provide welder qualifications for each welder for each weld type. It is highly recommended that the Contractor use ASME Form E00008, QW-484 "Suggested Format for Manufacturer's Record of Welder or Welding Operation Qualification Tests (WPQ)." The WPQs shall be performed under the witness of an independent agency. 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. The qualifying test segment must be a 2 inch nominal pipe size with wall thickness within range of the WPS. Tests position shall be "6G" per ASME Section IX.
   2. Evidence of Continuity: Welder qualifications must be current. If the qualification test is more than 6 months old, provide record of welding continuity for each welder. 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. 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, the Contractor shall submit for approval an administrative procedure for recording, locating, monitoring, and maintaining the quality of all welds to be performed on the project. This quality control document 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 that shall be used to identify all of his welds. A list of qualified persons with their respective numbers shall be submitted by the Contractor and shall be 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. Identification marks shall be made by using a rubber stamp or felt-tipped marker with permanent, weatherproof ink or other methods approved by the Engineer that do not deform the metal. For seam welds, identification marks shall be placed adjacent to the welds at 3-foot intervals. Identification by die stamps or electric etchers will not be allowed. The markers are to be provided by the Contractor. Substituting a map of welds with welders' names shall not be acceptable.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Provide factory-applied plastic end-caps on each length of pipe conduit. Maintain end-caps through shipping, storage and handling to prevent pipe-end damage and prevent entrance of dirt, debris, and moisture.

B. Protect stored pipes and conduit. Elevate above grade and enclose with durable, waterproof wrapping. When stored inside, do not exceed structural capacity of the floor.

C. Protect flanges, fittings, and specialties from moisture and dirt by inside storage and enclosure, or by packaging with durable, waterproof wrapping.

## PART 2 - PRODUCTS

2.1 UNDERGROUND PIPE MATERIALS AND FITTINGS

A. Systems Designs
1. Medium Pressure Steam: Normal operating conditions are 50 PSIG at 298 degrees F. Design conditions for the system shall be 60 PSIG at 341 degrees F. Note: This is superheated, as this system is downstream of a regulating valve.

B. Service Pipe: Steam piping shall be A106, Grade B seamless. Steam piping 2 inches NPS and below shall be Schedule 80. Steam piping 2-1/2 inches NPS and above shall be hard Schedule 40. All joints shall be butt-welded for sizes 2-1/2 inches and greater, and socket welded for 2 inches and below. Where possible, straight sections shall be supplied in 40 foot random lengths with 6 inches of piping exposed at each end for field joint fabrication.

C. Fittings: Fittings 2 inches and smaller shall be 3000-pound socket-weld in accordance with ANSI B16.11. Material shall conform to ASTM A105. Fittings 2 1/2 inches and larger shall be steel butt-welding type in accordance with ANSI B16.9 and with the same wall thickness as the attached pipe. Material shall conform to ASTM A234, Grade WPB.

D. Sub-Assemblies: Gland seals, end seals, and anchors shall be designed and factory prefabricated to prevent the ingress of moisture into the system. All sub-assemblies shall be designed to allow for complete draining and drying of the conduit system. Anchors shall be prefabricated steel plates, factory furnished and installed where shown on plans. A 4,000 psi concrete block shall be cast over the plate and conduit and shall be large enough for firm anchorage into undisturbed trench sidewalls and/or bottom. Size of anchor and concrete encasement shall be per piping manufacturer’s

recommendation.

E. Insulation: Service pipe insulation shall be Pyrogel XTE, as manufactured by Aspen Aerogel, 30 mm minimum; outer conduit insulation shall be polyurethane, 1 inch minimum. Insulation shall be held in place by stainless steel bands installed on not less than 18 inch centers. The insulation shall have passed the most recent boiling test and other requirements specified in the Federal Agency Guidelines. The insulation shall be applied to a total thickness which limits the maximum sustained temperature of the outer jacket to 100 degrees F.

F. Outer Conduit: The steel conduit casing shall be 10 gauge, airtight, pressure testable, smooth wall welded steel conduit. The steel conduit shall withstand H-20 loading with a minimum of 24 inches of cover.

G. Outer Conduit Insulation and Jacket: Conduit insulation shall be a minimum of 1-inch thick factory applied polyurethane foam, meeting ASTM C591. The outer jacket shall be:

1. High Density Polyethylene (HDPE) jackets with a minimum wall thickness of 0.1750 inches. A pressure testable electric-fusion process or heat shrinkable (recommended by the manufacturer) HDPE field joint closures equal to or greater in thickness to the outer jacket shall be used to complete the installation closure. No shrink wrap type will be allowed for closure joints. Apply two additional heat shrinkable HDPE field joint closures overlapping the ends of the first field joint closure to provide a layering joint.

H. Pipe Supports: All pipes within the inner casing shall be supported at not more than 10 foot intervals. These supports shall be designed to allow for continuous airflow and drainage of the conduit in place. The straight supports shall be designed to occupy not more than 10% of the annular air space. Supports shall be of the type where insulation thermally isolates the carrier pipe from the outer conduit. Supports which directly contact both the carrier pipe and the outer casing shall not be allowed. The surface of the insulation shall be protected at the support by a sleeve not less than 12 inches long, fitted with traverse and where required, rotational arresters.

I. Expansion Loops, Ells and Tees: Expansion loops and Ells shall be of proper design in accordance with stress limits indicated by the code for pressure piping ASME B31.1. Loop piping shall be installed in conduit suitable sized to handle anticipated pipe movement. Cold springs will not be permitted.

J. Backfill: A 6-inch layer of sand or pea gravel shall be placed and tamped in the trench to provide a uniform bedding for the conduit. The entire trench shall be evenly backfilled with a similar material as the bedding in 6-inch compacted layers to a minimum height of 6-inches above the top of the insulated piping system. Bedding and backfill materials shall be as recommended by the manufacturer.

K. Manufacturers: Rovanco “Insul 800 Elite”.

2.2 BURIED UTILITY WARNING AND IDENTIFICATION TAPE:

A. Provide detectable aluminum foil plastic backed tape or detectable magnetic plastic tape manufactured specifically for warning and identification of buried piping. Tape shall be detectable

by an electronic detection instrument. Provide tape in rolls, 6-inches minimum width, color yellow, with warning and identification imprinted in big black letters continuously and repeatedly over entire tape length. Warning and identification shall read "CAUTION BURIED STEAM SYSTEM DISTRIBUTION PIPING BELOW" or similar wording. Use permanent code and letter coloring unaffected by moisture and other substances contained in trench backfill material.

B. Copper Tracer Wire: Install a No. 12-gauge solid copper tracer wire with 45 mils polyethylene with each buried pipe to facilitate location. Wire shall be installed directly above each pipe and terminate at manholes or building penetrations.

2.3 ABOVEGROUND PIPE MATERIALS AND FITTINGS

A. Systems Designs
1. Medium Pressure Steam: Normal operating conditions are 50 PSIG at 298 degrees F. Design conditions for the system shall be 60 PSIG at 341 degrees F. Note: This is superheated, as this system is downstream of a regulating valve.

B. Service Pipe: Steam piping shall be A106, Grade B seamless. Steam piping 2 inches NPS and below shall be Schedule 80. Steam piping 2-1/2 inches NPS and above shall be hard Schedule 40. All joints shall be butt-welded for sizes 2-1/2 inches and greater, and socket welded for 2 inches and below. Where possible, straight sections shall be supplied in 10 foot random lengths with 6 inches of piping exposed at each end for field joint fabrication.

C. Fittings: Fittings 2 inches and smaller shall be 3000-pound socket-weld in accordance with ANSI B16.11. Material shall conform to ASTM A105. Fittings 2 1/2 inches and larger shall be steel butt-welding type in accordance with ANSI B16.9 and with the same wall thickness as the attached pipe. Material shall conform to ASTM A234, Grade WPB.

D. Insulation:
1. Insulation shall be 100 percent rigid cellular glass, totally inorganic, with no binder. Absorption of moisture shall be 0.2% or less per ASTM C240. Water-vapor permeability shall be 0 perm-in per ASTM E96. Average compressive strength shall be 90 psi ASTM C165. Average density shall be 7.5 lb. per cubic foot per ASTM C303. Maximum service temperature shall be 900 degrees F. Thermal conductivity shall be no greater than 0.29 Btu-in/hr.-sq. Ft. - degree F at mean temperature of 75 degrees F per ASTM C177 and C518. The insulation shall conform to ASTM E84 (5 Flame, 0 Smoke). Linear expansion shall be 3 inches per 100 linear feet at 600 degrees F. Insulation shall be fabricated in half sections wherever possible. For large diameter piping where half sections are not practical, curved side wall segments are preferred. Provide double layer system with staggered joints for all systems where pipe temperature is listed as 400 degrees F or greater.
2. Fittings and valves shall be insulated with the same insulation system and built-up to the same thickness as the insulation for the adjoining pipe in accordance with insulation manufacturer's instructions.
3. Provide insulation from one of the following manufacturers and product trade names:

| Manufacturer | Trade Name of Approved Product |
|---|---|
| Pittsburgh Corning<br>800 Presque Isle Drive | FOAMGLAS |

Pittsburgh, PA 15239
Phone Number: (800) 359-8433

4. Provide 2-inches of insulation in all locations.
5. Pipe surfaces shall be clean and dry prior to insulating. Insulation may be temporarily held in place with stainless steel wire or fiber reinforced tape overlapped a minimum of 6 inches prior to the insulation finish being installed. The tape and/or wire may remain on the insulation beneath the insulation finish.

E. Jacket:

1. Apply directly over the insulation an aluminum weatherproof jacket. This jacket shall be manufactured from aluminum alloy 5005 or 3003 half hard, not less than 0.016-inch-thick, fabricated with 3/16 inch corrugations running lengthwise of pipeline. The aluminum shall be factory attached to a moisture barrier of kraft paper treated for this service.
2. All joints shall be made rain or drip proof. Longitudinal joints shall be located on the side of the pipe with the open edge of the lap turned down to shed water. Circumferential joints on pipes that do not have enough slope to get a good shingle effect to keep water out of the joint shall have the inside end of the lap beaded or sealed with a permanently elastic mastic type sealant designed for this service.
3. The aluminum jacket shall be secured by aluminum straps 1/2-inch-wide by 0.020 inch thick. The straps shall be placed on 12 inch centers (maximum). Each circumferential joint shall have a strap at the midpoint of the lap.
4. On long radius bends, the aluminum jacket shall be in sections cut on the miter, overlapped, and forming a neat snug fit, using sufficient bands and fasteners to hold jacket properly in place.
5. All 30-inch diameter and smaller insulated elbows shall be protected with a prefabricated elbow jacket. The jacket shall be manufactured of high purity 0.024-inch aluminum with a suitable moisture barrier on the interior of the jacket to prevent decomposition of the aluminum. The prefabricated elbow jacket shall be applied directly over the insulated fitting.
6. All insulation on fittings, flanges, valves, and other irregular shaped items on which the aluminum jacket cannot be neatly applied shall be finished as follows:
    a. Over the smooth insulation surface and cloth reinforcing as described below, apply the mastic in two or more coats at a sufficient rate to provide a dry film thickness of 1/8 inch.
    b. The mastic shall be applied by trowel or spray. The exact application conditions, procedures and recoat time shall be as recommended by the mastic manufacturer.
    c. Reinforcing shall consist of a No. 10 mesh nylon or Dynel cloth. Flat surfaces shall be secured to the insulated structure on 18 inch centers maximum.
    d. The mastic shall be gray or metallic gray vinyl VI-CRYL CP-10 or CP-11 manufactured by Childers Products Company, 35555-T Curtis Blvd., Eastlake, OH 44095; Phone Number: (216) 953-5200; or WC-1 manufactured by Vimasco Corporation, Dept. TR, P.O. Box 516, Nitro, West Virginia 25143; Phone Number: (888) 276-9146.
    e. Upon completion of the work, the Contractor shall furnish the A/E a certificate stating that the mastic has been applied in the same manner as specified or approved by its manufacturer.

## PART 3 - EXECUTION

### 3.1 UNDERGROUND PIPING INSTALLATION

A. The installing contractor shall handle the system in accordance with the directions furnished by the manufacturer and as approved by the engineer. Seal the ends of pipes with caps or tape to prevent debris from entering the pipe prior to welding. Follow the manufacturer's approved method for cleaning the piping prior to testing.

B. The contractor shall take all precautions necessary to prevent groundwater or stormwater from entering the uncompleted pipe (service pipe, insulation, outer conduit, or outer jacket), including storing the prefabricated piping outside the trench, installing pumps to artificially lower the groundwater table, providing temporary watertight end closures, or other acceptable method. The contractor shall submit his plans for maintaining the pipe dry. Pipe that becomes wet shall be replaced by the contractor at no additional cost to the owner.

### 3.2 ABOVEGROUND PIPING

A. Installations:
   1. General:
      a. Install pipes and pipe fittings in accordance with recognized industry practices which will achieve permanently-leak-proof piping systems, capable of performing each indicated service without piping failure. Install each run with minimum joints and couplings. Reduce sizes (where indicated) by use of reducing fittings. Align piping accurately at connections, within 0.05 inches' misalignment tolerance.
      b. Provide lock-out/tag-out of existing piping systems before doing tie-in work. Coordinate with the Owner.
   2. Piping Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location arrangement and restrictions of the piping systems. Location and arrangement of piping layout shall take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated.
   3. Piping Alignment:
      a. Install piping free of sags or bends and with ample space between piping to permit proper insulation applications.
      b. Install exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated on the Contract Drawings.
      c. Locate groups of pipes parallel to each other, spaced to permit applying full insulation, servicing of valves, and thermal expansion of piping systems.
      d. Electrical Equipment Spaces: Do not run piping through transformer vaults and other electrical rooms or electronic equipment spaces and enclosures. In no instance shall piping be routed above electrical equipment.
   4. Interferences: Do not run piping or conduits through ducts or equipment cabinets.
   5. Shop Prefabrication:
      a. Where shop prefabrication is not specified but is done as the Contractor's choice, any adjustments necessary due to inaccuracies in equipment setting and dimensions or location of existing obstructions shall be done at no additional cost. No shop

fabrication sketches will be checked by the Engineer, but Contractor shall submit drawings to the Engineer for information.

b. All shop fabrication shall be fabricated to dimensional tolerances in accordance with Pipe Fabrication Institute Standard ES-3. Accumulated tolerances between fixed points shall not exceed plus or minus 3/8 inch.

c. The Owner and the Engineer reserves the right to visit the Contractor's shop to review shop fabrications and shop quality control procedures.

6. Thermal Cutting: When thermal cutting is required, the material shall be in accordance with ASME B31.1 welding preheat requirements. Thermal cut surfaces shall be ground to remove all slag, oxide, and surface irregularities to 1/16 inch.

7. Welded Attachments:

a. Welded attachments shall include lugs, brackets, and similar devices welded to pipe for hangers, supports, and guides. Weld procedures used to attach such devices shall be compatible with the base material. Preheating shall be in accordance with ASME B31.1 requirements for piping material.

b. All areas where lugs or attachments are removed or repaired shall be tested hydrostatically to meet accepted standards stated in ASME B31.1. Any linear indications shall be removed and the area retested. The procedure shall be repeated until no indications are noted.

B. Fittings and Specialties

1. Use fittings for all changes in direction and all branch connections. For piping greater than 2 inch NPS, if the change in direction is less than 5 degrees, a miter is acceptable and must be provided in accordance with ASME B31.1. No miters are acceptable for angles greater than 5 degrees. For changes in direction greater than 5 degrees, cut a forged fitting. For pipe sizes 2 inch NPS and smaller, changes in direction shall be done with standard 45 and 90 degree elbows – no miters or cut fittings acceptable.

2. Pipe Elbows: Provide pipe elbows where depicted on the Contract Drawings. Use long radius elbows except where specifically designated on the Contract Drawings.

3. Branches: Wherever branch pipe is indicated, install type of fitting shown on Contract Drawings, i.e. forged branch connection fitting (weld-o-lets and sock-o-lets), regular "T" fitting, or reducing "T" fitting. If the type of fitting is not shown on the Contract Drawings or specified in the piping specifications, the Contractor may choose between the above mentioned fittings, within the limits of the following:

a. Forged branch connection fittings may only be used if the smaller branch pipe is at least two standard nominal pipe sizes smaller than the larger main pipe. No "stub-ins" are permitted.

b. All fittings and procedures conform to the specific piping group specification as scheduled in this Section.

4. Reducers: Unless explicitly stated on Contract Drawings, use forged fittings. Use concentric fittings except for steam systems, for reducers in horizontal in direction of flow, use eccentric flat on bottom to allow condensate to continue flowing in direction of steam travel. Use eccentric flat on top for natural gas. Pay attention to requirements at pump suction and discharge on details. No mitered fittings are allowed.

C. Joints

1. Welded Joints:

a. General:

1) Weld pipe joints only when ambient temperature is above 0-degree F where possible.
2) Bevel pipe ends at a 37.5-degree angle where possible, smooth rough cuts, and clean to remove slag, metal particles, and dirt.
3) 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.
4) Build up welds with stringer-bead pass, followed by hot pass, followed by cover or filler pass. Eliminate valleys at center and edges of each weld. Weld by procedures which will ensure elimination of unsound or unfused metal, cracks, oxidation, blow-holes, and non-metallic inclusions.
5) Do not weld-out piping system imperfections by tack-welding procedures; refabricate to comply with requirements.
6) If piping component ends are bored, such boring shall not result in the finished wall thickness after welding less than the minimum design thickness.
7) The inside diameters of piping components to be butt-welded shall be aligned as accurately as is practicable within existing commercial tolerances on diameters, wall thickness and out of roundness. Alignment shall be preserved during welding. The internal misalignment of the ends to be joined shall not exceed 0.05 inch.

b. Welding Processes:
1) All welding on metal piping systems shall be done using qualified welding and qualified welders and welding operators in accordance with Section IX of the ASME Boiler and Pressure Vessel Code.
2) All welding shall be done by a process that is compatible with the work being welded and the working conditions.
3) Where a specific welding process is called for in the piping group, it shall govern.
4) Shielded metal-arc welding (SMAW) shall not be used on work less than 3/16 inch thick. The root pass and the hot pass for the SMAW shall be E6010. The remaining shall be completed with E7018.
5) Any weld, at the Contractor's discretion may done per the GTAW tungsten inert gas (TIG) method with E6010. The E6010 can be substituted with ER-70S-2 or ER70S-3.
6) Pulse welding in the form of MIG (Metal Inert Gas) is not allowed for welds of this project. No spray welding is allowed.

c. Welding Grooves:
1) The ends of steel pipe and fittings to be erected with butt welded joints shall be beveled to form welding grooves in accordance with ANSI B16.25, except where otherwise noted in these Specifications, or on the Contract Drawings.
2) Welding grooves for butt welded joints in pipe of unequal wall thickness shall be beveled in accordance with ASME Code for Pressure Piping B31.1 - latest edition, latest revision and section that is applicable.

d. Backing Rings: Backing rings or consumable inserts shall not be used and are not allowed.

e. Cleaning of Welding: All slag or flux remaining on the bead of welding shall be completely removed before laying down the next successive bead and at the completion of the weld.

f. 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.
g. Weld Quality:
   1) All welds shall have full penetration and complete fusion with a minimum of weld metal protruding on the inside of the pipe.
   2) The finished weld contour shall be uniform, with the toe or edge of the weld merging smoothly into the base material. Butt welds shall have a slight reinforcement build-up gradually from the toe or edge toward the center of the weld. 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. Fillet welds may be slightly concave on the finished surface.
h. Identification of Welders: Refer to Quality Assurance paragraph of Part 1 of this Section.

2. Socket Welding Joints: Where socket welding valves or fittings are used, the pipe shall be spaced 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. 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.
3. Flanged Joints:
   a. Match flanges within piping system and at connections with valves and equipment where specified. Clean flange faces and install gaskets. Tighten bolts to provide uniform compression of gaskets. Hot torqueing may be required during start-up to cycling does not cause leaks.
   b. All slip-on flanges are to be welded on front and back, no exceptions. Welding neck flanges shall be bored to match the attached pipe.
   c. Flange faces shall be in perfect alignment, with holes straddling the principal centerlines. Ordinary or special-type flanged joints shall be kept to a minimum to reduce any possibility of leakage. Continuous runs of piping shall be used, wherever possible. All bolts in flanged construction shall be uniformly tightened with proper wrenches only. Hammering and bumping are prohibited. Care shall be taken to secure uniform pressure on the gasket and to avoid overstressing of the bolts, dishing of flanges, and compression of the gasket beyond limits. All bolts shall be well lubricated over the entire thread with a heavy graphite-and-oil mixture prior to tightening operation.
   d. Bolting with Spiral-Wound Gaskets: All steel bolts shall be tightened to obtain a cold stress between 30,000 and 45,000 psi. Torque, if used, shall be correlated to bolt stress by onsite strain testing.
   e. Bolting with Rubber Gaskets: Bolts shall be uniformly tightened to compress gaskets approximately one-half of their original thickness. Care shall be taken to avoid damaging the gasket by over tightening.

## 3.3 BURIED UTILITY WARNING AND IDENTIFICATION TAPE

A. Polyethylene plastic tape shall possess a detectable metal core and be manufactured specifically for warning of and identifying buried utility lines and shall be supplied and installed by Contractor. Tape shall be buried above the pipe during the trench backfilling operation and shall be buried

approximately 12 inches below grade.

3.4 INSULATION INSTALLATION

A. General: Install insulation material with smooth and even surfaces. Unless otherwise specified, install insulation materials, accessories, and finishes in accordance with the manufacturer's published recommendations.

B. Fire Precaution: Care shall be exercised by the Contractor that no cutting, welding, or open flames are permitted in the areas where flammable mastics or other materials are used. The precaution period shall extend until the material has cured sufficiently so that no further fire hazard exists.

C. Insulation Release: Before insulation is applied to any piping or equipment, the Contractor shall obtain from the Engineers a written release stating that the item is ready for insulation.

D. Manufacturer's Recommendations: All materials specified herein shall be installed in full accordance with the manufacturer's recommendations for the best performance and durability of his product, notwithstanding any requirements or omissions herein with respect to preparation of equipment before insulating or method of application.

E. Surface Condition: Do not apply insulation materials until all surfaces to be covered are clean and dry, all foreign materials, such as rust, scale, and dirt have been removed, and surfaces have been painted. Insulation shall be clean and dry when installed and during the application of any finish.

F. Moisture and Vapor Seal: Provide a complete moisture and vapor seal wherever insulation terminates against metal hangers, anchors and other projections through insulation on cold surfaces for which a vapor seal is specified.

G. Asbestos Containing Material: No Contractor, Subcontractor, or Supplier shall furnish any asbestos containing material.

3.5 UNDERGROUND PIPING TESTS

A. Supplier’s representative shall be present during testing.

B. Outer Jacket Air Test
   1. In cases that a HDPE outer jacket is used, the Contractor shall furnish all necessary equipment and labor to perform the air test, including air compressor, gauges, conduit caps, temporary pipe connections, etc. and complete the test to the satisfaction of the engineer.
   2. Conduct each outer jacket air test under the supervision of the supplier’s representative. The supplier’s representative shall provide documentation of every field closure outer jacket inspection and air test. The HDPE outer jacket shall be tested per the manufacturer’s recommendation.

C. Conduit Air Test
   1. The Contractor shall furnish all necessary equipment and labor to perform the air test, including air compressor, gauges, conduit caps, temporary pipe and connections, etc. and

complete the test to the satisfaction of the Engineer. The outer conduit shall be tested to 15 psi and held for 2 hours.

2. Conduct each conduit air test under the supervision of the supplier's representative. The supplier's representative shall provide documentation of each conduit inspection and air test.

3.6 PIPING TESTS - HYDROSTATIC

A. General:

1. Provide temporary equipment for testing, including pump and gages. The 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. Test piping system before insulation is installed. Pressure testing shall be performed following the completion of postweld heat treatment, nondestructive examinations, and all other fabrication, assembly, and erection activities required to the provide the system or portions thereof subjected to the pressure test with pressure retaining capability. Remove control devices before testing. 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. Fill each section with water and pressurize for indicated pressure and time. The Contractor shall provide air vents at all high points in the system to purge air pockets while the system is filling.
2. The Contractor shall test each section of pipe before it is connected to the existing piping. Provide temporary piping including welded caps prior to the termination into near end of new piping so that new piping can be hydrostatically tested. After successfully hydrostatic testing, remove the temporary caps and provide new piping to tie into existing piping. It is recognized that the final connection pieces to existing piping will not be hydrostatically tested; however, flow (at normal operating pressure) shall be established through the final connection pieces and fittings, with no visual evidence of weeping or leakage prior to insulation.
3. Testing shall be performed with calibrated test gages (Contractor furnished) in the presence of the Owner or Engineer.
4. The Contractor shall furnish all temporary pipe, fittings, and pumps required to perform the tests.
5. Pipe hangers, snubbers, or restraints shall be blocked, disconnected, or pinned, as required, prior to pressure testing or cleaning and shall be restored to operating condition following such test.
6. Equipment and instruments shall be isolated and openings shall be plugged, as required, to accomplish the required testing and cleaning and to prevent over pressurizing connecting piping or equipment. Relief and safety valves shall be removed and the respective nozzle blanked for testing of the associated equipment. Do not gag relief valves – remove them.
7. The equipment to which any piping system is attached shall not be subjected to any line tests. The test pressures apply to the piping materials as specified but shall not be assumed to apply to piping specialties, accessories, or equipment, including safety heads, rupture disks, relief valves, expansion joints, instruments, or filters. Items that may be damaged by the test pressure shall either be removed or blanked off.
8. Lines containing check valves shall have the source of test pressure located on the upstream side.

B. Test Pressure:

1. The test pressure shall be 90 PSIG. Do not deviate from stated test pressure.

2. The test pressure shall be continuously maintained for a minimum time of 4 hours. During this 4-hour period, no pressure drop shall be measured. After the 4-hour period, if necessary, the pressure may then be reduced to design pressure and held for such time as may be necessary to continue to conduct the examinations for leakage. Examinations for leakage shall be made of all joints and connections. The piping system shall show no visual evidence of weeping or leaking. Hydrostatic testing shall be witnessed by the Owner or Engineer. After any leaks are found and corrected, the test shall be repeated.

C. Test Blinds:
1. If during the field testing of piping it becomes necessary to insert test blinds in any part of this piping, the Contractor shall provide test blinds and all work required including the flanges and welding of flanges.
2. Test blinds shall be equipped with a long handle.
3. The Contractor shall submit a written description of the location of test blinds before testing.
4. The Contractor shall remove all test blinds after testing.

D. Repair piping systems sections which fail required piping test, by disassembly and re-installation, using new materials to extent required to overcome leakage. Do not use chemicals, stop-leak compounds, mastics, or other temporary repair methods.

E. Records:
1. It is the responsibility of the Contractor to keep accurate, updated records of all pressure testing. The Contractor shall submit a final log of all pressure testing for the Owner's records.
2. The Contractor shall maintain a constantly updated listed of the following for all pressure tests:
   a. Date and time of test.
   b. Test pressure.
   c. Testing medium.
   d. Piping system tested.
   e. Extent of piping system tested so that it can be clearly identified up to what point a piping system has been tested.
   f. Test results. All failures shall be indicated with the cause explicitly stated.
   g. Signed witnesses of each test which shall be one employee of the Contractor, Engineer, an Owner representative, and the CxA.

F. Hydrostatic Testing
1. All non-boiler external piping shall be hydrostatically tested in accordance with Paragraph 137 of the ASME B31.1 Power Piping Code, except for fuel oil and natural gas piping.
2. The test water for hydrostatic tests shall be clean and of such quality as to minimize corrosion of the materials in the piping system. The temperature of the test medium shall be a minimum of 60 degrees F, unless the Engineer specifies otherwise. The test pressure shall not be applied until the system and the pressurizing medium are approximately at the same temperature.
3. The Contractor shall provide air vent valves at all high points in the system to purge air pockets while the system is filling and drain valves at all low points to drain system.
4. The system shall be filled with water; care being taken that air is completely vented from

the top of system so that there are no air pockets remaining.

5. Vent and drain piping shall be leak tested by using 6.5 PSIG pressure or by maintaining a 15-foot water column, either applied to the highest point of the line being tested. The extent of the test shall be an initial service leak test in accordance with Paragraph 137.7 of ASME B31.1.
6. The leak test shall be considered satisfactory if no leakage is discovered on the piping or at any joints and if no sweating due to porosity is discovered on piping or at joints. Lines requiring repairing shall be retested to the pressure originally specified. The piping system, exclusive of possible localized instances at pumps or packing, shall show no evidence of leaking.
7. Drain test water from piping systems after testing has been completed.

3.7 PIPING TESTS - VISUAL EXAMINATION

A. General: The Independent Testing Agency will examine 100% of all pipe welds per ASME B31.1.

B. Acceptance Standards:
   1. The acceptance standards for visual examination shall be as defined in ASME B31.1, Paragraph 136.4.2.A, and are repeated here for convenience. The following indications are unacceptable:
      a. Cracks-external surface.
      b. Undercut on surface which is greater than 1/32-inch deep.
      c. Weld reinforcement greater than that specified in Table 127.4.2. of ASME B31.1.
      d. Lack of fusion on surface.
      e. Incomplete penetration (applies only when inside surface is readily accessible).
      f. Any other linear indications greater than 3/16-inch long.
      g. Surface porosity with rounded indications having dimensions greater than 3/16-inch or four or more rounded indications separated by 1/16-inch or less edge to edge in any direction. Rounded indications are indications which are circular or elliptical with their length less than three times their width.
   2. In addition, acceptance will also be based on the proper lay-out, materials, and methods, as specified.

C. Failed Welds:
   1. All welds not passing visual examination shall be repaired or replaced at no expense to the Owner.
   2. Visual defects found shall require additional VT as recommended by inspector.
   3. Do not begin to repair or replace the weld until the weld report has been submitted to the Engineer and the Engineer gives approval for repairing the weld with the method that the Contractor proposes. Repair shall be performed using the qualified welding procedures applicable to the original weld.
   4. The Owner reserves the right to permanently remove any welder who fails 3 visual inspections from the Project.

D. Reporting:
   1. Reports preformed for visual examinations by the Contractor are not required to be submitted, but shall be kept available for review at any time by the Owner or Engineer.

E. Visual Examination Requirements:
1. Welds designated for visual examination will be examined after the weld is completed for cracks, contour and finish, bead reinforcement, undercutting, overlap, size of fillet welds, finished weld appearance, weld size, weld length, dimensional accuracy of weldment, and monitor post weld heat treatment.
2. Records of visual examinations must be kept as described in this Section.
3. Shop fabricated welds may be examined in the shop prior to arrival at the project site provided all other conditions of this Section are satisfied.

F. Examiner's Scope:
1. The Contractor shall provide all required access and lighting for the independent testing agency.

3.8 PIPING TESTS - RADIOGRAPHIC EXAMINATION (RT)

A. General: The Independent Testing Agency will examine 100% of all pipe welds per ASME B31.1.

B. Acceptance Standards: Shall be in accordance with Paragraph 136.4.5 of ASME B31.1. The Engineer may, at his sole discretion, elect to waive some of the acceptance standards on a case by case basis.

C. Radiation Safety Concerns:
1. RT may be minimized at the project site at the discretion of the Owner due to the potential concern for maintaining operations and potentially having areas being cordoned off due to potential radiation from the RT process.

D. Radiographic Examination Requirements:
1. The Contractor is responsible for providing access to the welds for the Independent Testing Agency.
2. It is suggested to the Contractor that the Contractor should schedule welds that require scaffolding are complete so that the Contractor will not have to re-build scaffolding to gain access to the welds.
3. Shop fabricated welds shall be examined in the shop (off site) to allow the Contractor to resolve issues in a more controlled environment and to reduce the annoyances of dealing with barricades and related coordination of radiation exposure at the project site.

E. Failed Welds:
1. All welds not passing radiography examination shall be repaired or replaced at no expense to the Owner of Engineer.
2. Do not begin to repair or replace the failed weld until the weld report has been submitted to the Engineer and Owner and the Engineer gives approval for repairing the weld with the method that the Contractor proposes. Repair shall be performed using the qualified welding procedures applicable to the original weld.
3. All failed welds discovered by radiographic examination shall be re-examined by radiographic examination after the weld is repaired or replaced at no additional cost to the Owner of Engineer with the report being submitted to the Engineer and the Owner within 2 working days of the examination which shall reference the repair of the particular weld.
4. The Owner reserves the right to permanently remove any welder who fails 3 radiographic

examinations from the Project.

3.9 FLUSHING AND CLEANING OF STEAM SYSTEM

A. Contractor shall visually inspect internal portion of each length of pipe during installation. Remove all dirt and foreign matter prior to installing additional lengths.

B. Fill piping with water and conduct the specified hydrostatic pressure testing and completely drain system to system low point(s).

C. Provide temporary piping or hose to bypass any component, which may be damaged, unless acceptable means of protection are provided and subsequent inspection of hide-out areas takes place.

D. All cleaning and flushing shall be performed such that all debris will be pulled or flushed downhill.

E. Contractor shall provide access at all low points through valves, tees, flanges, etc. to facilitate the cleaning and flushing process. If temporary fittings or piping is required, it shall be provided by the Contractor and removed by the Contractor after successful cleaning.

F. After flushing and cleaning is completed, Contractor shall provide necessary pipe and fittings required to complete the piping system. Each cleaned section of piping shall be capped and protected to keep mud, debris, water, etc. from entering the piping. If a piping section is left open or unprotected, or is found to be contaminated, it shall be re-cleaned prior to being filled and activated at no cost to the Owner.

G. Contractor shall provide all water for flushing and cleaning. Coordinate rental of fire hydrant meters with local Fire Department(s), or the utility owner. Contractor is responsible for legal disposal of all existing high temperature hot water in piping and all water used for flushing and cleaning.

H. Contractor shall provide all temporary piping from water source to piping system and shall provide means for conducting cleaning water from underground piping system to the appropriate sewer; i.e. pumps, piping, hoses, tanks, etc.

3.10 VERIFICATION OF FINAL ELEVATIONS

A. Prior to covering the top of the casing with backfill material, but after all temporary supports have been removed and initial backfilling of the conduit systems have been accomplished, the contractor shall measure and record the elevation of the top of the casings in the trench. This measurement shall be checked against the contract drawings. These measurements shall confirm that the conduit system has been installed to the elevations shown on the contract drawings. These measurements shall be certified correct by the Contractor and provided to the Owner for review prior to covering the casing with backfill material. The pre-insulated conduit system shall be installed, inspected, and tested in accordance with the contract drawings and specifications, the system supplier's Approved Brochure and any directions given by the system supplier's representative. All work pertaining to the pre-insulated system shall be performed in the presence of the system supplier's representative.

B. END OF SECTION 336313