

# **Detroit Diesel Corporation**

**M1 Renovation  
13400 Outer Drive W  
Detroit, Michigan 48239**

**Project Manual  
Project No. 231609**

**BIDS & CONSTRUCTION**

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PROJECT MANUAL  
FOR  
DETROIT DIESEL CORPORATION

M1 RENOVATION  
13400 OUTER DRIVE W, DETROIT, MI 48239

October 30, 2024  
Project Number 231609

ARCHITECT/ENGINEER

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SECTION 00 01 10 – TABLE OF CONTENTS

DIVISION 01	GENERAL REQUIREMENTS
01 11 00	Summary of Work
01 18 13	Protection, Restoration and Notification
01 22 00	Unit Prices
01 23 00	Alternates
01 25 13	Product Substitution Procedures
01 26 13	Requests for Information
01 29 73	Schedule of Values
01 31 13	Project Coordination
01 31 19	Project Meetings
01 32 16	Construction Progress Schedule
01 33 00	Submittal Procedures
01 42 00	References
01 45 34	Special Inspections and Tests
01 50 00	Temporary Facilities and Controls
01 66 00	Product Storage and Handling Requirements
01 71 23	Field Engineering
01 73 29	Cutting and Patching
01 74 00	Cleaning and Waste Management
01 75 00	Starting and Adjusting
01 77 00	Closeout Procedures
01 78 39	Project Record Documents
01 91 13	General Commissioning Requirements
DIVISION 02	EXISTING CONDITIONS
02 01 26	Minor Alteration Work
02 41 19	Selective Demolition
DIVISION 03	CONCRETE
03 30 03	Cast-in-Place Concrete
DIVISION 05	METALS
05 30 00	Metal Decking
05 50 00	Metal Fabrications
05 73 00	Decorative Metal Railings
DIVISION 06	WOOD, PLASTICS, AND COMPOSITES
06 41 00	Architectural Wood Casework
06 42 00	Wood Paneling
DIVISION 07	THERMAL AND MOISTURE PROTECTION
07 01 50.19	Preparation for Re-Roofing or Roof Repair
07 21 19	Foamed-In-Place Insulation
07 84 00	Firestopping
07 92 00	Joint Sealants
DIVISION 08	OPENINGS
08 11 13	Hollow Metal Doors and Frames
08 11 16	Aluminum Doors and Frames
08 43 13	Aluminum-Framed Storefronts
08 71 00	Door Hardware
08 80 00	Glazing

DIVISION 09	FINISHES
09 05 61	Common Work Results for Flooring Preparation
09 21 16	Gypsum Board Assemblies
09 30 00	Tiling
09 51 00	Acoustical Ceilings
09 54 00	Specialty Ceilings
09 65 00	Resilient Flooring
09 68 13	Tile Carpeting
09 77 00	Fiberglass Reinforced Wall Panels
09 84 30	Sound-Absorbing Wall and Ceiling Units
09 91 23	Interior Painting
DIVISION 10	SPECIALTIES
10 11 00	Visual Display Units
10 21 13.13	Metal Toilet Compartments
10 28 00	Toilet, Bath, and Laundry Accessories
10 44 00	Fire Protection Specialties
DIVISION 12	FURNISHINGS
12 36 00	Countertops
DIVISION 21	FIRE SUPPRESSION
21 05 00	General Fire Suppression Provisions
21 05 03	Steel Pipe and Fittings for Fire Suppression
21 05 09	Copper Pipe and Fittings for Fire Suppression
21 05 29	Hangers and Supports for Fire Suppression Piping and Equipment
21 05 31	Penetrations for Fire Suppression
21 10 00	Water Based Fire Suppression Systems
DIVISION 22	PLUMBING
22 05 00	General Plumbing Provisions
22 05 03	Steel Pipe and Fittings for Plumbing
22 05 06	Cast Iron Pipe and Fittings for Plumbing
22 05 09	Copper Pipe and Fittings for Plumbing
22 05 19	Meters and Gages for Plumbing Piping
22 05 23	General Duty Valves for Plumbing
22 05 29	Hangers and Supports for Plumbing Piping and Equipment
22 05 31	Penetrations for Plumbing
22 05 73	Testing and Cleaning of Plumbing Systems
22 07 19	Plumbing Piping Insulation
22 10 00	Plumbing Piping and Specialties
22 10 23	Natural Gas Piping System
22 40 00	Plumbing Fixtures
DIVISION 23	HEATING, VENTILATING, AND AIR CONDITIONING
23 01 00	Operation and Maintenance of HVAC Systems
23 05 00	General HVAC Provisions
23 05 13	Common Motor Requirements for HVAC Equipment
23 05 29	Hangers and Supports for HVAC Piping, Ductwork and Equipment
23 05 31	Penetrations for HVAC
23 05 46	Sound and Vibration Control for HVAC
23 05 73	Testing and Cleaning of HVAC Systems
23 05 93	Testing, Adjusting and Balancing for HVAC
23 07 13	Duct Insulation
23 08 00	Commissioning of HVAC

23 09 00	Instrumentation and Control for HVAC
23 31 13	Metal Ducts
23 33 13	Dampers
23 34 23	HVAC Power Ventilators
23 36 00	Air Terminal Units
23 37 00	Air Outlets and Inlets
23 40 00	HVAC Air Cleaning Devices
23 74 43	Packaged, Outdoor Heating and Cooling Units
23 82 50	Electric Convection Heating Units
DIVISION 26	ELECTRICAL
26 05 00	Common Work Results for Electrical
26 05 20	Conductors and Cables - 600V and Below
26 05 27	Grounding and Bonding
26 05 29	Hangers and Supports for Electrical Systems
26 05 34	Raceways for Electrical Systems
26 05 35	Boxes for Electrical Systems
26 05 36	Cable Trays for Electrical Systems
26 05 53	Identification for Electrical Systems
26 05 73	Overcurrent Protective Device Coordination Study and Arc Flash Risk Assessment
26 08 13	Electrical Testing
26 09 23	Lighting Control Devices
26 22 13	Low Voltage Distribution Transformers
26 24 16	Panelboards
26 27 26	Wiring Devices
26 28 00	Low Voltage Circuit Protective Devices
26 28 20	Enclosed Switches
26 29 13	Enclosed Controllers
26 50 00	Lighting
DIVISION 28	ELECTRONIC SAFETY AND SECURITY
28 31 00	Fire Detection and Alarm

END OF TABLE OF CONTENTS

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## SECTION 01 11 00 – SUMMARY OF WORK

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 WORK COVERED BY CONTRACT DOCUMENTS

- A. The Work covered by the Contract Documents comprises construction of the M1 Renovation project located at 13400 Outer Drive W, Detroit, MI 48239 for the Detroit Deisel Corporation.
- B. The Work includes the following major items:
  - 1. Exterior renovation, including;
    - a. Site work and drive restoration
    - b. Exterior envelope modifications for installation of new windows.
    - c. Roof modifications for new HVAC equipment.
    - d. Mechanical system upgrades.
    - e. Electrical system upgrades.
  - 2. Interior renovation, including:
    - a. Reconfiguration of space for new offices and conference rooms.
    - b. Updates to existing restrooms.
    - c. Architectural finish updates
    - d. Mechanical system upgrades.
    - e. Electrical system upgrades.

#### 1.3 GENERAL

- A. Imperative Language: These Specifications (Divisions 01 through 43) are written in the imperative and abbreviated form. This imperative language of the technical specifications is directed at Contractor unless specifically noted otherwise. Incomplete sentences shall be completed by inserting "shall", "shall be" and similar mandatory phrases by inference in the same manner as they are applied to notes on Drawings. The words "shall", "shall be" and similar mandatory phrases shall be supplied by inference where a colon (:) is used within sentences or phrases. Except as worded to the contrary, fulfill (perform) all indicated requirements whether stated in the imperative or otherwise.
- B. Related Sections: Some Sections of these Specifications (Divisions 01 through 43) may include a paragraph titled "Related Sections". This paragraph is an aid to the Project Manual user and is not intended to include all Sections which may be related. It is Contractor's obligation to coordinate all Sections whether indicated under "Related Sections" or not.
- C. Reference to the General Conditions: In Divisions 01 through 43, a reference to the General Conditions includes by inference all amendments or supplements in the Supplementary Conditions.

#### 1.4 CONTRACTOR USE OF PREMISES

- A. Limit use of premises to allow for Owner occupancy and work by other contractors.
- B. Limit construction traffic access to Site from main entrance to the Detroit Diesel Corporation.
- C. Coordinate use of premises under direction of the Owner.
- D. Where the Contract Documents identify certain site elements within the construction limits, such as sidewalks, drives, and streets, that must be kept open for public or the Owner's use during construction, the Contractor shall be responsible for protection and maintenance of such elements as well.

- E. Except in connection with the safety or protection of persons or the Work or property at the Site or adjacent thereto, all Work at the site shall be restricted to the following hours:
  - 1. Monday through Saturday (Except Legal Holidays): 7 a.m. to 5 p.m.
  - 2. Sundays or legal holidays with written approval of the Owner.

#### 1.5 OCCUPANCY REQUIREMENTS

- A. Owner Occupancy During Construction:
  - 1. The Owner will occupy or utilize the first floor of Anibal House during entire period of construction. Cooperate with the Owner to minimize conflict and to facilitate the Owner's operations.
  - 2. Access to Abutting Properties: Provide at all times.
  - 3. Access for Emergency Vehicles:
    - a. Provide at all times.
    - b. Provide at least one clear lane during nonwork periods.
  - 4. Fire Hydrants: Provide access to at all times.
  - 5. Do not block fire access routes.
  - 6. Detours and Street Closure:
    - a. When provided for in the Contract Documents or approved by the Owner.
    - b. Routes and barricades as indicated or as approved by the Owner.
  - 7. Limit parking for construction vehicles to an area designated by the Owner.

#### 1.6 WORK SEQUENCE

- A. Coordinate construction schedule and operations with Owner a minimum of 2 weeks in advance. Work shall not be performed during wet weather or high flow events and all equipment/systems shall be operational during these events. Contractor shall coordinate their work so that the first floor of Anibal House remains operational during the entire construction period. For processes where redundant equipment exists, shutdowns shall be coordinated one at a time and shall be of a duration approved by the Owner. For processes where redundant equipment does not exist, shutdowns shall be coordinated as directed by the Owner for the duration established by the Owner.
- B. Sequence Submittal: Submit a proposed sequence with appropriate times of starting and completion of tasks to Owner and Architect for review.
- C. General:
  - 1. Contractor shall be solely responsible for all construction sequencing and scheduling required by the Contract Documents.
  - 2. Coordinate timing of all work with Owner.
  - 3. Coordinate timing and sequencing of the Work to maintain plant operations for the duration of the Work.

#### 1.7 SALVAGED MATERIALS

- A. Ownership:
  - 1. Owner shall have the option of retaining ownership of any or all existing equipment, materials, and items removed under this Work.
  - 2. Should Owner decide not to retain ownership of certain items removed under the Work of this Section, those items shall become property of Contractor and shall be promptly removed from the Project Site.
- B. Delivery: Deliver items which remain property of Owner to a location, or locations, as selected by the Owner and on Site.

### PART 2 - PRODUCTS

#### 2.1 OTHER MATERIALS

- A. General: All other materials which are not specified herein and are not indicated on the Drawings, but are required for proper and complete performance of the Work.

- B. Procedure:
  - 1. Select new, first quality material.
  - 2. Obtain Architect's review.
  - 3. Provide and install.

### PART 3 - EXECUTION

#### 3.1 PROVISIONS

- A. General: Perform the work to provide for occupied facilities to be in effective operation at all times.
- B. Notification of Owner: Notify Owner at least 72 hours prior to starting to relocate piping or taking existing components out of service.

END OF SECTION 01 11 00

## SECTION 01 18 13 – PROTECTION, RESTORATION AND NOTIFICATION

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. This Section includes responsibilities for the protection, restoration and notification requirements for surface and subsurface structures, Underground Facilities and surface improvements.

#### 1.3 NOTIFICATION AND INTERRUPTIONS

- A. Prior to Start of Construction:
  - 1. Notify MISS DIG at least 72 hours in advance at 1-800-482-7171.
  - 2. Arrange for the identification of the locations of existing Underground Facilities at or contiguous to the Site.
  - 3. Coordinate utility connection with each utility provider.
- B. Utility Interruptions:
  - 1. Provide standby utility service for an interruption exceeding 2 hours.
  - 2. Provide 72 hours notice to the Owner of the time and duration of the anticipated system shut off.
  - 3. Notify Fire Department 48 hours in advance if water main or fire supply line shut off is required.

#### 1.4 PROTECTION AND RELOCATION

- A. Be Responsible For:
  - 1. Protection of structures and utilities at or contiguous to the Site in accordance with the General Conditions.
  - 2. Cost of cleaning, repair, relocation, raising, lowering, or replacement of structures and utilities which interfere with new Work or are damaged as a result of Contractor's operations.
  - 3. Temporary sheeting, bracing, poles, cables, sand fill or other means used to support a structure or utility exposed or endangered by Contractor's operations.
  - 4. Relocating, raising or lowering of a structure or utility for Contractor's convenience.
- B. Relocation of Poles and Structures:
  - 1. Be responsible for temporary and permanent relocation of power, light, telephone and other service poles and appurtenant structures.
  - 2. Make necessary arrangements with the owner of the pole or structure and pay all costs involved.

#### 1.5 RESTORATION

- A. Acceptable Standards for Restoration:
  - 1. Restore to the better of:
    - a. Original condition.
    - b. Requirements of the Contract Documents.
- B. Driving Surfaces and Similar Improvements:
  - 1. Repair or replace damaged or removed surfaces as specified herein.
  - 2. Adjust to temporary or final grade all new and existing castings (water valve boxes, manholes, catch basins and similar structures) for all gravel, bituminous or concrete surfacing or resurfacing.

- C. Landscaping and Miscellaneous Improvements:
1. Includes, but is not limited to, topsoil, seeded areas, sodded areas, shrubs, trees, decorative plantings, fences, signs, guard posts and other similar items.
  2. Protect from damage by construction operations. In event of damage, replace damaged item with one of equivalent type and size.
  3. Adjust to temporary or final grade all new and existing castings (water valve boxes, manholes, catch basins, and similar structures).
- D. Cleanup Limitation:
1. Maintain cleanup operations within a reasonable distance of construction. Reasonable will depend on circumstances, but in general shall not exceed 400-600 feet, and except in rare circumstances and with prior approval of Owner, shall not exceed 1,000 feet.
  2. Cleanup shall consist of grading, removal of excess excavation and construction debris, temporary repair of roads and drives, and maintenance of ditch slopes.
  3. If cleanup is not maintained as specified, other construction shall be stopped, with no extension of Contract Time, until cleanup is carried out to the satisfaction of Owner.

## PART 2 - PRODUCTS

Not used.

## PART 3 - EXECUTION

### 3.1 SURFACE RESTORATION

- A. Unless Otherwise specified or indicated on the Drawings, perform the following surface restorations:
1. System Descriptions:
    - a. Aggregate Base Course - Bituminous Paved Roadway and Parking Lot:
      - 1) Subbase: 8 inches.
      - 2) Aggregate Base Course:
        - a) Access Roadway: 8 inches.
        - b) Parking Lot: 8 inches.
      - 3) Bituminous Leveling Course:
        - a) Access Roadway: 2 inches.
        - b) Parking Lot: 2 inches.
      - 4) Bituminous Top Course: 2 inches.
    - b. Concrete Sidewalks:
      - 1) Subbase: 4 inches.
      - 2) Concrete: 4 inches.
      - 3) Reinforcing: 6 x 6 - W1.4 x W1.4.
    - c. Turf Establishment - Sodding and Seeding:
      - 1) Topsoil Thickness: 4 inches.
      - 2) Perform final grading, watering, backfilling of washouts, and related work.
      - 3) Sodded and seeded areas shall be weed free and established prior to acceptance.
  2. Material requirements for surface restoration unless specified otherwise:
    - a. Subbase: MDOT Granular Material Class II.
    - b. Aggregate Base Course: MDOT Dense Graded Aggregate 21AA.
    - c. Aggregate Surface Course: MDOT Dense Graded Aggregate 22A.
    - d. Bituminous Leveling Course: MDOT 13A.
    - e. Bituminous Top Course: MDOT 36A.
    - f. Concrete Roadway Pavement: MDOT 35P.
    - g. Concrete Driveways and Approaches: MDOT 35P.
    - h. Concrete Curb and Gutter: MDOT 35S.
    - i. Concrete Sidewalk: MDOT 35P.
    - j. All Other Materials: Incidental and as required by MDOT.
  3. Construction Standards for Surface Restoration: Comply with MDOT construction requirements unless otherwise specified or indicated on the Drawings.

3.2 PAYMENT FOR UTILITIES AND ASSOCIATED STRUCTURES

- A. Payment for Work on Utilities and Associated Structures damaged during construction:
1. If Work is by Utility Company: Contractor pays costs.
  2. If Work is by Contractor: Perform work in accordance with the requirements of utility company or authority having jurisdiction and Contractor pays associated costs.

END OF SECTION 01 18 13

## SECTION 01 22 00 - UNIT PRICES

### 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 administrative and procedural requirements for unit prices.

#### 1.3 DEFINITION

- A. Unit Price: A unit price is an amount proposed by Bidders and stated on the Bid Form as a price per unit of measurement for materials or services that will be added to or deducted from the Contract Sum by Change Order if estimated quantities of Work required by the Contract Documents are increased or decreased

#### 1.4 PROCEDURES

- A. Unit prices include necessary material, overhead, profit and applicable taxes.
- B. Refer to individual Sections
  1. For demolition or construction activities requiring establishment of unit prices.
  2. For requirements for materials and methods described under each unit price.
- C. Owner reserves the right to reject the Contractor's measurement of Work-in-place that involves the use of established unit prices, and to have this Work measured by an independent surveyor acceptable to the Contractor at the Owner's expense.
- D. List of Unit Prices: A schedule of unit prices is included in the Form of Proposal.
- E. List of Unit Prices: A schedule of unit prices is included in Part 3.

### PART 2 - PRODUCTS (NOT APPLICABLE)

### PART 3 - EXECUTION

#### 3.1 SCHEDULE OF UNIT PRICE ITEMS

- A. Unit Price Items:
  1. Unit Price No. 1: Topping out gypsum board and metal stud walls.
    - a. Provide a price to extend existing walls to deck with the same construction as the existing walls. Provide a price to furnish, patch, prep, prime, and apply two topcoats of paint.
    - b. Unit of Measure: 10 lineal feet.
    - c. Quantity: 1.
    - d. Refer to Division 09 for gypsum board assemblies and painting specifications.
  2. Unit Price No. 2: Additional painting.
    - a. Provide a price to furnish, patch, prep, prime, and apply two topcoats.
    - b. Unit of Measure: 100 square feet.
    - c. Quantity: 1.
    - d. Refer to Division 09 for painting specification.

3. Unit Price No. 3: Ceiling replacement.
  - a. Provide a price to demolish existing ceiling system then furnish and install new acoustical ceiling system including ceiling grids and pads.
  - b. Unit of Measure: 100 square feet.
  - c. Quantity: 1.
  - d. Refer to Division 09 Section "Acoustical Ceilings."
4. Unit Price No. 4A: Access panels 24-inch x 24-inch.
  - a. Provide a price for a new flush gypsum access panel.
  - b. Unit of Measure: 1 access panel.
  - c. Quantity: 1.Unit Price No. 4B: Access panels 12-inch x 12-inch.
  - d. Provide a price for a new flush gypsum access panel.
  - e. Unit of Measure: 1 access panel.
  - f. Quantity: 1.Unit Price No. 4C: Access panels 8-inch x 8-inch.
  - g. Provide a price for a new flush gypsum access panel.
  - h. Unit of Measure: 1 access panel.
  - i. Quantity: 1.
5. Unit Price No. 5: Trench infill.
  - a. Provide a price to fill in existing, abandoned, and remediated utility trenches.
  - b. Unit of Measure: 10 square feet.
  - c. Quantity: 1.
  - d. Refer to Division 03 for concrete specification.

END OF SECTION 01 22 00



SECTION 01 23 00 – ALTERNATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. General provisions of the Contract, including Owner's Division 00, General and Supplementary Conditions, and Division 01 Specification Sections, apply to this Section.
- B. Division 01 provisions of the Construction Specification, and the Construction Drawings, apply to this Section.

1.2 SUMMARY

- A. This Section identifies each alternate and describes the basic changes to be incorporated into the Work, only when that alternate is made a part of the Work by specific provisions of the Contract Documents.

1.3 SCHEDULE OF ALTERNATES

- A. Alternate 1: Provide the additional cost for the demolition and new work associated with finish, mechanical, and electrical work located in Axle Production Office #214.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

Not used.

END OF SECTION 01 23 00

## SECTION 01 25 13 – PRODUCT SUBSTITUTION PROCEDURES

### 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 administration of substitutions and Product options.

#### 1.3 SUBMITTALS

- A. List of all products proposed for installation:
  - 1. Submit 5 copies within 30 days after the Effective Date of Agreement unless otherwise indicated elsewhere in the Contract Documents.
  - 2. Tabulate the list by each Specification Section.

#### 1.4 CONTRACTOR'S OPTIONS

- A. Products specified only by reference standards or by description:
  - 1. Select any Product meeting the standards or description by any Supplier unless otherwise required elsewhere in the Contract Documents.
  - 2. Submit for Architect/Engineer's review:
    - a. Name and address of Supplier.
    - b. Trade name.
    - c. Model or catalog designation.
    - d. Manufacturer's data including:
      - 1) Performance and test data
      - 2) Compliance with reference standards.
- B. Products specified by naming one or more suppliers without an "or equal" clause:
  - 1. Use specified Product of one of the Suppliers named.
  - 2. No substitutions.
- C. Products specified by naming one or more suppliers with an "or equal" clause:
  - 1. Indicates the option of selecting equivalent Products by stating "or equal" after the specified Suppliers.
  - 2. Architect/Engineer may waive some or all of the requirements specified for substitutions if, at Architect/Engineer's sole discretion, the proposed equivalent Product is considered an "or equal".
  - 3. If, at Architect/Engineer's sole discretion, the proposed equivalent Product does not qualify as an "or equal", it will be considered as a proposed substitute and a substitution request submittal will be required.

#### 1.5 SUBSTITUTIONS

- A. Substitutions after the effective date of agreement:
  - 1. Substitutions requests shall be reviewed and submitted during bidding, any substitutions submitted post-bid may be rejected
  - 2. Architect/Engineer will consider formal requests for substitution of Products in place of those specified unless otherwise prohibited elsewhere in the Contract Documents.
- B. Substitution Request Submittals: Submit 5 copies of the request for substitution including the following:
  - 1. Complete data substantiating compliance of the proposed substitution with the Contract Documents.
  - 2. For Products:
    - a. Names and addresses of Manufacturer and Supplier.
    - b. Product identification.

- c. Manufacturer's literature, including:
      - 1) Product description.
      - 2) Performance and test data
      - 3) Reference standards.
    - d. Samples.
    - e. Name and address of similar projects on which the Product was used and date of installation.
  - 3. For Construction Methods:
    - a. Detailed description of the proposed method.
    - b. Drawings illustrating methods.
  - 4. Itemized comparison of proposed substitution with Product or method specified.
  - 5. Data relating to changes in the construction schedule.
  - 6. Accurate cost data on the substitution and comparison with the Product or method specified.
  - 7. Changes to the Work which would be caused by the substitution.
- C. Contractor's Responsibilities: In making a request for a substitution, Contractor represents:
  - 1. Contractor has personally investigated the proposed Product or method and determined that it is equal or superior in all respects to that which is specified.
  - 2. The Contractor shall provide a detailed comparison, in a written document, proving the performance criteria to duly prove that substituted products are equal.
  - 3. Contractor will provide the same guarantee for the substitution as for the Product or method specified.
  - 4. Contractor will coordinate installation of the accepted substitution into the Work making such changes as may be required for the Work to be completed in all respects.
  - 5. Contractor waives all claims for additional cost related to the substitution which consequently become apparent.
  - 6. Cost data is complete and includes all related costs under Contractor's contract, but excludes costs under separate contracts and Architect/Engineer's redesign costs.
    - a. If redesign is required, the Contractor shall compensate the Architect/Architect/Engineer on an hourly basis for the changes.
- D. Substitutions Not Considered: Substitutions will not be considered if:
  - 1. They are indicated or implied on Shop Drawings or Product data submittals without formal request submitted in accordance with this Section.
  - 2. Acceptance will require substantial revision of the Contract Documents.

## PART 2 - PRODUCTS

Not used.

## PART 3 - EXECUTION

Not used.

END OF SECTION 01 25 13

## SECTION 01 26 13 – REQUESTS FOR INFORMATION

### 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 procedures for Contractor to give notice of conflicts, errors, ambiguities, or discrepancies in the Contract Documents.

#### 1.3 DEFINITIONS

- A. Abbreviation: Request for Information (RFI).

#### 1.4 REQUESTS FOR INFORMATION

- A. Format:
  - 1. Use the enclosed RFI form or, at Contractor's option, generate form. Electronic construction management software such as Procore may be used.
  - 2. Minimum required content of Contractor's RFI form:
    - a. Project name.
    - b. Name and address of Contractor.
    - c. RFI number.
    - d. RFI date.
    - e. Name of initiator.
    - f. Complete written request, with sketches as required.
    - g. Signature of initiator.
    - h. Space for written response by Architect/Engineer, with signature and date of Architect/Engineer's representative.
- B. Procedures:
  - 1. Maintain a log of RFIs, including the RFI date and the date of the response.
  - 2. Allow at least 15 full working days for Architect/Engineer's response following Architect/Engineer's receipt of RFI.
  - 3. Submit written justification for shorter response time.
  - 4. Do not submit RFIs for information already included in the Contract Documents.
  - 5. Illegitimate RFIs may be cause for deductions in the Contract amount.
    - a. Compensation:
      - 1) Should Architect/Engineer be required to respond to RFI's with information already included in the Contract Documents, Architect/Engineer will record expenses for performing all additional reviews.
      - 2) Owner will compensate Architect/Engineer for these additional services and deduct the amount paid from payments to Contractor.
  - 6. RFIs submitted directly by subcontractors or vendors will be rejected.
  - 7. Changes in Contract Price or Contract Times not permitted within an RFI form.

### PART 2 - PRODUCTS

Not Used.

### PART 3 - EXECUTION

#### 3.1 SCHEDULES

- A. Attached is the following form:
  - 1. Request for Information.

REQUEST FOR INFORMATION  
PAGE 1 OF 1

CONTRACT FOR:	PROJECT NO.:
OWNER:	
CONTRACTOR:	
ENGINEER:	
THE CONTRACTOR SHALL COMPLY WITH THE PROCEDURES IN DIVISION 01 SECTION "REQUESTS FOR INFORMATION."	

RFI No.: \_\_\_\_\_

Fishbeck Project Manager: \_\_\_\_\_

REQUEST		
<b>RFI From:</b>	<b>Signature:</b>	<b>Date:</b>

RESPONSE		
<b>Response From:</b>	<b>Signature:</b>	<b>Date:</b>

END OF SECTION 01 26 13

## SECTION 01 29 73 – SCHEDULE OF VALUES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. This Section includes preparation and submittal of a schedule of values.

#### 1.3 GENERAL

- A. Timing of Submittal:
  - 1. Submit to Architect/Engineer a draft schedule of values allocated to the various portions of the Work, within 10 days after the Notice of Award.
  - 2. Submit to Architect/Engineer a final schedule of values allocated to the various portions of the Work, within 10 days after the Preconstruction Meeting.
- B. Supporting Data: Upon request of Architect/Engineer, support the values with data which will substantiate their correctness.
- C. Use of Schedule: The schedule of values, unless objected to by Architect/Engineer, shall be used only as the basis for the Contractor's Applications for Payment.

#### 1.4 FORM AND CONTENT OF SCHEDULE OF VALUES

- A. Form and Identification:
  - 1. Type schedule on 8-1/2-inch x 11-inch white paper.
  - 2. Contractor's standard forms and automated printout may be used.
  - 3. Identify Schedule with:
    - a. Title of Project and location.
    - b. Architect/Engineer.
    - c. Project number.
    - d. Name and address of Contractor.
    - e. Contract designation.
    - f. Date of submission.
- B. Detail: Schedule shall list the installed value of the component parts of the Work in sufficient detail to serve as a basis for computing values for progress payments during construction.
- C. Format:
  - 1. Follow the Table of Contents of this Project Manual as the format for listing component items.
  - 2. Identify each line item with the number and title of the respective major Section of the Specifications.
- D. Subvalues: For each major line item list subvalues of major Products or operations under the item.
- E. Allowances: Allowances are not part of the specified requirements.
- F. Change Orders: For each Application for Payment, revise schedule to list Change Orders.
- G. For the various portions of the Work:
  - 1. Each item shall include a directly proportional amount of Contractor's overhead and profit.
  - 2. For items on which progress payments will be requested for stored materials, break down the value into:
    - a. The cost of the materials, delivered and unloaded, with taxes paid.
    - b. The total installed value.

H. The sum of all values listed in the schedule shall equal the total Contract Price.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

Not used.

END OF SECTION 01 29 73

## SECTION 01 31 13 – PROJECT COORDINATION

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. This Section includes provisions for coordination of the Work.

#### 1.3 GENERAL COORDINATION

- A. Coordinate scheduling, submittals and work of the various Sections of the Specifications to:
  - 1. Ensure efficient and orderly sequence of installation of interdependent construction elements.
  - 2. Provide for items to be installed later.
- B. Interrelated Operating Equipment:
  - 1. Verify that characteristics of elements are compatible.
  - 2. Coordinate work of various sections having interdependent responsibilities for:
    - a. Installation.
    - b. Connection.
    - c. Placing in service.
- C. Space Coordination Between the Trades:
  - 1. General:
    - a. Coordinate the layout and space requirements of all trades including but not limited to:
      - 1) Mechanical.
      - 2) Lighting.
      - 3) Electrical distribution system.
      - 4) Communication network.
      - 5) Process piping.
      - 6) Structural systems.
  - 2. Drawings:
    - a. The Drawings of the following system are diagrammatic and not to scale. Each trade shall use required offsets, bends, and special connections, which are not necessarily indicated on the Drawings, but which are required for proper installation:
      - 1) Mechanical.
      - 2) Electrical distribution.
      - 3) Communication network.
      - 4) Process piping.
    - b. Follow the routing diagrammatically indicated in the Drawings as closely as practical.
  - 3. Space Utilization and Accessibility:
    - a. Utilize space efficiently to maximize accessibility for:
      - 1) Other systems.
      - 2) Maintenance.
      - 3) Repairs.
  - 4. Layout: Layout systems parallel with lines of the building.
  - 5. Shop Drawings: Carefully review and revise the Shop Drawings from the various trades to ensure that space requirements for all systems are coordinated.
  - 6. Additional Payments: No additional payments will be made by Owner due to location adjustments of systems or installations of offsets, bends, and special connectors necessary for proper installation.



#### 1.4 ACCEPTANCE OF CONDITIONS

- A. Inspection:
  - 1. Prior to performing any work under a section:
    - a. Carefully inspect the installed work.
    - b. Verify that all such work is complete to the point where the work under that Section may properly commence.
    - c. Starting of work indicates acceptance of the condition of components to which the work will be applied.
  - 2. Verify that all materials, equipment and Products to be installed under a Section may be installed in strict accordance with the original design and reviewed Shop Drawings.
- B. Discrepancies:
  - 1. Resolve all discrepancies and conflicts between the trades.
  - 2. Do not proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved.

#### 1.5 SLEEVES AND INSERTS

- A. Function: For pipes, conduits and similar items in forms, walls and floors.
- B. Trades: Furnish required sleeves and inserts.
- C. Place sleeve and inserts in ample time so as to not delay work.
- D. Except as approved by Engineer, do not place sleeves vertically through:
  - 1. Beams.
  - 2. Girders.
  - 3. Similar construction.
- E. Maintain in proper position during subsequent work.

#### PART 2 - PRODUCTS

Not used.

#### PART 3 - EXECUTION

Not used.

END OF SECTION 01 31 13

## SECTION 01 31 19 – PROJECT MEETINGS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. This Section includes scheduling and administering of preconstruction and progress meetings.
- B. Scheduling and Administration of Meetings:
  - 1. Responsibility:
    - a. Preconstruction Meeting: Construction Manager.
    - b. Progress Meetings: Construction Manager.
  - 2. Procedures:
    - a. Prepare agenda.
    - b. Distribute written notice and agendas of meetings.
    - c. Make physical arrangements for the meetings.
    - d. Preside at meetings.
    - e. Record minutes and include significant proceedings and decisions.
    - f. Distribute copies of the minutes to:
      - 1) Participants.
      - 2) Others affected by proceedings.

#### 1.3 PRECONSTRUCTION MEETING

- A. Schedule: Preconstruction meeting will be scheduled by Construction Manager before starting the Work at the Site.
- B. Attendance: Representatives of the following parties are to be in attendance at the meeting:
  - 1. Owner.
  - 2. Architect/Engineer.
  - 3. Construction Manager.
  - 4. Major Subcontractors.
  - 5. Governmental or regulatory agencies when appropriate.

#### 1.4 PROGRESS MEETINGS

- A. Types of Progress Meetings:
  - 1. Regular.
  - 2. Called.
- B. Schedule meetings as follows:
  - 1. Regular: Weekly throughout construction.
  - 2. Called: As the progress of the Work dictates.
  - 3. Pre-demolition/installation: At least 5 working days prior to start of work.
- C. Location:
  - 1. Regular Meetings: Onsite Construction Office.
- D. Minimum Agenda: The minimum agenda for progress meetings shall consist of the following:
  - 1. Review and approve minutes of previous meetings.
  - 2. Review progress of the Work since the previous meeting.
  - 3. Review milestones of the Work in the project schedule.
  - 4. Note field observations, problems, and decisions.

5. Identify problems which impede planned progress.
6. Review offsite fabrication problems.
7. Develop corrective measures and procedures to regain plan schedule.
8. Revise construction schedule as indicated.
9. Review submittal schedules; expedite as required to maintain schedule.
10. Maintenance of quality and work standards.
11. Review changes proposed by Owner for their effect on the construction schedule and completion date.
12. Identify all claims and potential claims.
13. Pending changes and substitutions.
14. Complete other current business.

#### PART 2 - PRODUCTS

Not used.

#### PART 3 - EXECUTION

Not used.

END OF SECTION 01 31 19

## SECTION 01 32 16 – CONSTRUCTION PROGRESS SCHEDULE

### 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 preparation, furnishing, distribution and periodic revision of construction progress schedules.

### PART 2 - PRODUCTS

#### 2.1 FORM OF SCHEDULE

- A. Preparation:
  - 1. Prepare in the form of a horizontal bar chart, CPM network, or other form as approved by the Architect prior to submission.
  - 2. Provide a separate horizontal bar column or path for each trade or operation.
  - 3. Prepare the schedule in the chronological order of the beginning of each item of work.
  - 4. Identify each column or path by:
    - a. Major Specification Section number.
    - b. Distinct graphic delineation.
  - 5. Use a horizontal time scale and identify the first work day of each week.
  - 6. Allow space for updating.
- B. Size: The schedule sheets shall be 11 inches x 17 inches unless otherwise approved by the Architect.

#### 2.2 CONTENT OF SCHEDULES

- A. Construction Sequence:
  - 1. Provide a complete sequence of construction by activity Milestones.
  - 2. For Shop Drawings, project data and Samples indicate the following:
    - a. Submittal dates.
    - b. Dates review copies will be required.
  - 3. Show decision dates for selection of finishes.
  - 4. Show Product procurement and delivery dates.
  - 5. Show dates for beginning and completion of each element of construction.
- B. Percentage Completion: Show the projected percentage of completion for each item of work as of the first day of each month.
- C. Subschedules:
  - 1. Provide separate subschedules showing submittals, review times, procurement schedules and delivery days.
  - 2. Provide subschedules to define critical portions of the entire schedule.

### PART 3 - EXECUTION

#### 3.1 SUBMITTAL

- A. Preliminary Schedule:
  - 1. Submit the preliminary schedule within 10 days after the date of the Owner's signature on the Agreement Supplement.
  - 2. The Architect will review schedule and will return the reviewed copy within 15 days after receipt.

3. If required, resubmit within 7 days after receipt of a returned review copy.
4. Upon request, meet with the Architect at least 10 days prior to the submission of the first Application for Payment to review the schedule.

- B. Adjustment: Submit a revised schedule accurately depicting adjustments and progress at each progress meeting.

### 3.2 DISTRIBUTION

- A. Reviewed Schedules: Distribute copies of the reviewed schedules to:

1. Meeting attendees.
2. Job site file.
3. Subcontractors.
4. Other concerned parties.

- B. Instructions to Recipients: Instruct recipients to report inability to comply with the schedule, and provide detailed explanations with suggested remedies.

### 3.3 ADJUSTMENT OF PROGRESS SCHEDULE

- A. Changes: Show changes occurring since previous submission of the schedule.

- B. Progress: Indicate progress of each activity and show completion dates.

- C. Other Items:

1. Include major changes in scope.
2. Include activities modified since previous updating.
3. Include revised projections due to changes.
4. Include other identifiable changes.

END OF SECTION 01 32 16

## SECTION 01 33 00 – SUBMITTAL PROCEDURES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. This Section includes procedures for the submittal of Shop Drawings, Product Data, Samples, Operation and Maintenance Manuals, and other information.
- B. Related Sections include pertinent Sections of these Specifications for the individual Submittals required.

#### 1.3 DEFINITIONS

- A. Submittal: Information sent by Contractor to convey information about systems, equipment, materials, products, and administrative matters for the Work.
- B. Resubmittal: Submittal sent for review a second or further time.
- C. Product Data: Illustrations, standard schedules, diagrams, performance charts, instructions, brochures, or manufacturer's literature that describe the physical size, appearance, and other characteristics of materials or equipment for a portion of the Work.
- D. Shop Drawings: Drawings, diagrams, illustrations, schedules, and other data or information which are specifically prepared or assembled by or for Contractor and submitted by Contractor to illustrate some portion of the Work.
- E. Samples: Physical examples of materials, equipment, or workmanship that are representative of some portion of the Work and which establish the standards by which such portion of the Work will be judged.
- F. Action Submittals: Submittals that require Architect/Engineer's response.
- G. Informational Submittals: Submittals that do not require Architect/Engineer's response.
- H. Delegated-Design: In certain individual Specification Sections, design services or certifications by a design professional that are specifically delegated to the Contractor. Performance and design criteria are defined in the individual Specification Sections or on the Drawings. Contractor is solely responsible for design of those items or systems, and achieving specified performance.
- I. Portable Document Format (PDF): An open standard file format licensed by Adobe Systems used for representing documents in a device-independent and display resolution-independent fixed-layout document format.

#### 1.4 SUBMITTAL PROCEDURES

- A. Submittal Schedule:
  - 1. Prepare and submit, at the Preconstruction Meeting, a Submittal schedule that identifies the following for each Submittal:
    - a. Submittal number
    - b. Submittal description
    - c. Projected date Submittal will be submitted.
  - 2. An electronic copy (MS Excel file) of a blank Submittal schedule, in the preferred format, will be furnished by Architect/Engineer with the Notice to Proceed.

3. Submittal Numbers:
  - a. Use the applicable Specification Section number followed by a decimal point and then a sequential number (e.g., 06 10 00.1). Where a Submittal is required via a Drawing (instead of a Specification Section), use the applicable Drawing Number followed by a decimal point and then a sequential number (e.g., M501.1).
  - b. Resubmittals shall include a letter suffix after another decimal point (e.g., 06 10 00.1.A).
  - c. Submittals that are not numbered correctly may be rejected.
  
- B. Delivery Method: Submittals shall be delivered as electronic files.
  1. Electronic Files:
    - a. Unless indicated otherwise, submit 1 copy of each Submittal in PDF format.
    - b. Scanned Submittals shall be produced in such a way as to not compromise the graphic quality or accuracy of scale, where applicable; and text shall be searchable.
    - c. One copy of each Action Submittal will be returned to Contractor.
    - d. Submittals may be transmitted via electronic mail (e-mail) or on a CD or DVD. Submittals that are transmitted electronically may be returned electronically at the Architect/Engineer's discretion.
  2. Transmit Submittals to party and address identified by Architect/Engineer at preconstruction meeting.
  3. Engineer shall receive a copy of all transmittals.
  
- C. Coordination and Timing: Coordinate preparation and processing of Submittals with performance of construction activities. Contractor is responsible for cost of delays caused by lack of coordination or tardiness of Submittals. Incomplete Submittals will be rejected.
  1. Coordinate each Submittal with fabrication, purchasing, testing, delivery, other Submittals, and related activities that require sequential activity.
  2. Coordinate transmittal of different types of Submittals for related parts of the Work so processing will not be delayed because of need to review Submittals concurrently for coordination.
    - a. Architect/Engineer reserves the right to withhold action on a Submittal requiring coordination with other Submittals until related Submittals are received.
  
- D. Processing Time: Allow 10 full working days for Architect/Engineer to review each Submittal, including Resubmittals. Time for review shall commence on Architect/Engineer's receipt of Submittal. No extension of the Contract Time will be authorized because of failure to transmit Submittals enough in advance of the Work to permit processing, including Resubmittals. Architect/Engineer will advise Contractor when a Submittal being processed must be delayed for coordination.
  
- E. Identification: Place a permanent label on each Submittal or generate a separate cover sheet.
  1. Indicate name of firm or entity that prepared Submittal.
  2. Provide space to record Contractor's review and approval markings and action taken by Architect/Engineer.
  3. Include the following information:
    - a. Project name.
    - b. Date.
    - c. Name and address of Architect/Engineer.
    - d. Name and address of Contractor.
    - e. Name and address of Subcontractor(s).
    - f. Name and address of Supplier(s).
    - g. Name of Manufacturer.
    - h. Submittal number, including revision identifier.
    - i. Drawing number and detail references, as applicable.
    - j. Location(s) where product is to be installed, as applicable.
    - k. Other necessary identification.
  
- F. Deviations: Encircle or otherwise specifically identify deviations from the Contract Documents on Submittals. Submittals that include deviations that are not identified may be rejected. Architect/Engineer may or may not consider deviations. Deviations are not substitutions. Refer to Division 01 Section "Product Substitution Procedures" for procedures regarding requests for substitutions.
  
- G. Transmittal: Package each Submittal individually and appropriately for transmittal and handling. Transmit each Submittal using a transmittal form. Architect/Engineer will reject Submittal(s) received from sources other than Contractor.

- H. Resubmittals: Make Resubmittals in same form and number of copies as initial Submittal.
  - 1. Note date and content of previous Submittal.
  - 2. Clearly identify additions and revisions.
  - 3. Resubmit Submittals until they are marked, "Reviewed, No Exceptions Noted" or "Reviewed With Corrections Noted."
- I. Distribution: Furnish copies of Submittals with mark indicating, "Reviewed, No Exceptions Noted" or "Reviewed With Corrections Noted," to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities.
- J. Use for Construction: Unless otherwise indicated by Architect/Engineer, use only Submittals with mark indicating, "Reviewed, No Exceptions Noted" or "Reviewed With Corrections Noted."

#### 1.5 CONTRACTOR'S USE OF ARCHITECT/ENGINEER'S ELECTRONIC DRAWING FILES

- A. At Contractor's written request, copies of Architect/Engineer's electronic Drawing files may be provided to Contractor for Contractor's use in connection with Project, including Submittal preparation. Electronic files may be furnished by Architect/Engineer for the convenience of the Contractor. Conclusions or information obtained or derived from such electronic files will be at the Contractor's sole risk. Materials furnished by Consulting Engineer that may be relied upon are limited to printed Contract Documents.
- B. When Contractor uses Architect/Engineer's electronic Drawing files to facilitate Submittal preparation, prepare Submittals to be project specific. Submittals that are not project specific, including Architect/Engineer's Drawing files submitted on a new title block, will be rejected.

### PART 2 - PRODUCTS

#### 2.1 ACTION SUBMITTALS

- A. General: Prepare and submit project specific Action Submittals required by individual Specification Sections. Do not use highlighting that would not be reproducible.
- B. Product Data: Collect information into a single Submittal for each element of construction and type of product or equipment.
  - 1. If information must be specially prepared for Submittal because standard printed data are not suitable for use, submit as Shop Drawings, not as Product Data.
  - 2. Mark each copy of each Submittal to indicate which products and options are applicable.
  - 3. Include the following information, as applicable:
    - a. Manufacturer's written recommendations.
    - b. Manufacturer's product specifications.
    - c. Manufacturer's installation instructions.
    - d. Standard color charts.
    - e. Manufacturer's catalog cuts.
    - f. Wiring diagrams showing factory-installed wiring.
    - g. Printed performance curves.
    - h. Operational range diagrams.
    - i. Mill reports.
    - j. Standard product operation and maintenance manuals.
    - k. Compliance with specified referenced standards.
    - l. Testing by recognized testing agency.
    - m. Application of testing agency labels and seals.
    - n. Notation of coordination requirements.
  - 4. Submit Product Data before or concurrent with Samples.
  - 5. Maintain copy of returned Submittal for Project records.



- C. Shop Drawings: Prepare Project-specific information, drawn accurately to scale where appropriate. Scale shall be sufficiently large to indicate pertinent features of the item and its method of connection to the Work.
1. Preparation: Fully illustrate requirements of the Contract Documents. Include the following information, as applicable:
    - a. Dimensions.
    - b. Identification of products.
    - c. Fabrication and installation drawings.
    - d. Colors and materials as applicable.
    - e. Roughing-in and setting diagrams.
    - f. Wiring diagrams showing field-installed wiring, including power, signal, control, and communication wiring. Differentiate between Manufacturer-installed and field-installed wiring.
    - g. Manufacturing instructions.
    - h. Templates and patterns.
    - i. Schedules.
    - j. Calculations.
    - k. Compliance with specified standards.
    - l. Notation of coordination requirements.
    - m. Notation of dimensions established by field measurement.
    - n. Relationship to adjoining construction clearly indicated.
  2. Sheet Size: Submit Shop Drawings on sheets at least 8-1/2 inches x 11 inches but no larger than 24 inches x 36 inches.
  3. Maintain copy of returned Submittal for Project records.
- D. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other elements, and for a comparison of these characteristics between Submittal and actual component as delivered and installed.
1. Transmit Samples that contain multiple, related components, such as accessories, together in one Submittal package.
  2. Identification: On unexposed side of Samples, attach label that includes the following:
    - a. Generic description of Sample.
    - b. Product name and name of Manufacturer.
    - c. Sample source.
    - d. Number and title of appropriate Specification Section.
  3. Disposition: Maintain sets of approved Samples at Site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used by Architect/Engineer to determine final acceptance of construction associated with each set.
    - a. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such Samples shall be in an undamaged condition at time of Substantial Completion.
    - b. Samples not incorporated into the Work, or otherwise designated to become Owner's property, are the property of Contractor.
  4. Samples for Initial Selection: Submit Manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available. Where Contract Documents indicate custom color or material, coordinate production of custom Samples with the Architect/Engineer and Manufacturer prior to submittal.
    - a. Number of Samples: Unless indicated otherwise, submit 2 full set(s) of available choices where color, pattern, texture, or similar characteristics are required to be selected from Manufacturer's product line. Architect/Engineer will return 1 Sample with options selected.
  5. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, physically identical with material or product proposed for use, and that show full range of color and texture variations expected.
  6. Samples include, but are not limited to, the following: Partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.
  7. Number of Samples: Unless indicated otherwise, submit 2 sets of Samples. Architect/Engineer will retain 1 Sample set; remainder will be returned.
    - a. Submit a single Sample where assembly details, workmanship, fabrication techniques, connections, operation, and other similar characteristics are to be demonstrated.
    - b. If variation in color, pattern, texture, or other characteristic is inherent in material or product represented by a Sample, submit at least three sets of paired units that show approximate limits of variations.

8. Disposition: Maintain sets of approved Samples at Site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used by Architect/Engineer to determine final acceptance of construction associated with each set.
  - a. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such Samples shall be in an undamaged condition at time of Substantial Completion.
  - b. Samples not incorporated into the Work, or otherwise designated to become Owner's property, are the property of Contractor.

E. Operation and Maintenance Manuals:

1. General:
  - a. Where manuals are required to be submitted covering items included in the Work, prepare such manuals in durable plastic binders approximately 8-1/2 inches x 11 inches in size and with at least the following:
    - 1) Identification on, or readable through, the front cover stating general nature of the manual.
    - 2) Neatly typewritten index near the front of the manual.
    - 3) Complete instructions regarding operation and maintenance of equipment involved, including:
      - a) Equipment function, normal operating characteristics, and limiting conditions.
      - b) Assembly, installation, alignment, adjustment, and checking instructions.
      - c) Operating instructions for start-up, routine and normal operating, regulation and control, shutdown, and emergency conditions.
      - d) Maintenance instructions, including lubrication requirements where applicable.
      - e) Guide to "troubleshooting".
      - f) Parts lists and predicted life of parts subject to wear.
      - g) Project specific outline and cross sections, assembly drawings, engineering data, and wiring diagrams. Wiring diagrams shall reflect final, as-installed conditions and include wire numbers.
      - h) Test data and performance curves.
    - 4) Complete nomenclature of all replaceable parts, their part numbers, current costs, and name and address of nearest vendor of parts.
    - 5) Copies of guarantees and warranties issued.
    - 6) Copies of the reviewed Submittals.
    - 7) Copies of data concerning changes made during construction.
  2. Extraneous Data: Where contents of the manuals include Manufacturer's catalog pages, clearly indicate the precise items included in this installation and delete all Manufacturers' data with which this installation is not concerned. Do not use highlighting that would not be reproducible.
  3. Number of Copies Required: Unless otherwise specifically directed by Architect/Engineer, or stipulated in the pertinent Section of these Specifications:
    - a. For review, submit 1 paper and 1 electronic copy.
    - b. For record, deliver 5 paper and 1 electronic copies to Architect/Engineer.
  4. Schedule delivery of record copies of operation and maintenance manuals at least 60 days prior to startup of respective equipment, unless otherwise specified.

2.2 INFORMATIONAL SUBMITTALS

- A. General: Prepare and submit Informational Submittals required by individual Specification Sections. Do not use highlighting that would not be reproducible.
- B. Certificates and Certifications: Provide a notarized statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.
- C. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, names and addresses of architects/engineers and owners, and other information specified.
- D. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure Specification (WPS) and Procedure Qualification Record (PQR) on AWS forms. Include names of firms and personnel certified.

- E. Installer Certificates: Prepare written statements on Manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by Manufacturer for this Project.
- F. Manufacturer Certificates: Prepare written statements on Manufacturer's letterhead certifying that Manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.
- G. Product Certificates: Prepare written statements on Manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.
- H. Material Certificates: Prepare written statements on Manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.
- I. Material Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.
- J. Product Test Reports: Prepare written reports indicating current product produced by Manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by Manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.
- K. Research/Evaluation Reports: Prepare written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project. Include the following information:
  - 1. Name of evaluation organization.
  - 2. Date of evaluation.
  - 3. Time period when report is in effect.
  - 4. Product and manufacturers' names.
  - 5. Description of product.
  - 6. Test procedures and results.
  - 7. Limitations of use.
- L. Preconstruction Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.
- M. Compatibility Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.
- N. Field Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.
- O. Manufacturer's Instructions: Prepare written or published information that documents Manufacturer's recommendations, guidelines, and procedures for installing or operating a product or equipment. Include name of product and name, address, and telephone number of Manufacturer. Include the following, as applicable:
  - 1. Preparation of substrates.
  - 2. Required substrate tolerances.
  - 3. Sequence of installation or erection.
  - 4. Required installation tolerances.
  - 5. Required adjustments.
  - 6. Recommendations for cleaning and protection.

- P. Manufacturer's Field Reports: Prepare written information documenting tests and inspections of factory-authorized service representative. Include the following, as applicable:
1. Name, address, and telephone number of factory-authorized service representative making report.
  2. Statement of substrate condition and acceptability of substrate for installation or application of product.
  3. Statement that products at Site comply with requirements.
  4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
  5. Results of operational and other tests and a statement of whether observed performance complies with requirements.
  6. Statement whether conditions, products, and installation will affect warranty.
  7. Document settings in writing.
  8. Other required items indicated in individual Specification Sections.
- Q. Material Safety Data Sheets (MSDSs): Submit information directly to Owner; do not submit to Architect/Engineer.
1. Architect/Engineer will not review Submittals that include MSDSs and will return the entire Submittal for Resubmittal.

### 2.3 DELEGATED-DESIGN SUBMITTALS

- A. Where design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
- B. Performance type design documents and calculations shall be prepared by a design professional as required by the individual Specification Section, licensed in the State where the Project is being constructed. Design documents shall be signed and sealed by the responsible design professional. Prepare and submit written and graphic information, including, but not limited to, performance and design criteria, list of applicable codes and regulations, and calculations. Include list of assumptions and other performance and design criteria and a summary of loads. Include load diagrams if applicable. Identify name and version of software, if any, used for calculations.
- C. In addition to Shop Drawings, Product Data, and other required Submittals, submit two copies of a statement, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.

## PART 3 - EXECUTION

### 3.1 CONTRACTOR'S REVIEW

- A. Review each Submittal and check for coordination with other work of the Contract and for compliance with the Contract Documents. Verify field dimensions and conditions; note corrections as necessary. Mark with approval stamp before submitting to Architect/Engineer.
1. Approval Stamp: Stamp each Submittal with an approval stamp. Use the same stamp format for each Submittal. Include Project name and location, Submittal number, Specification Section title and number, name of reviewer, date of Contractor's approval, and statement certifying that Submittal has been reviewed, checked, and approved for compliance with the Contract Documents.
- B. Submittals that are not approved and stamped by Contractor will be rejected.

### 3.2 ARCHITECT/ENGINEER'S REVIEW

- A. Action Submittals: Architect/Engineer will review Action Submittals, make marks to indicate corrections or modifications required, and return Submittal. Architect/Engineer will stamp each Submittal with an action stamp and will mark stamp appropriately to indicate action taken, as follows:
1. Reviewed, No Exceptions Noted: Submittal appears to conform to the information given in the Contract Documents and be compatible with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents.
  2. Reviewed With Corrections Noted: Upon incorporation of review comments, it appears that Submittal will conform to the information given in the Contract Documents and be compatible with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents.
  3. Revise and Resubmit: Submittal has one or more specific segments that are incomplete, do not appear to conform to the information given in the Contract Documents, or are incompatible with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents. Contractor shall resubmit information for review to demonstrate understanding of comments and portions of Work to be provided. Except as noted, Contractor shall not proceed with work related to Submittal.
  4. Rejected, Resubmit: Submittal as a whole is incomplete, does not appear to conform to the information given in the Contract Documents, or is incompatible with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents. Contractor shall resubmit information for review to demonstrate understanding of comments and portions of Work to be provided. Contractor shall not proceed with work related to Submittal.
- B. Informational Submittals: Other Submittals required by the Contract Documents are for information only. Architect/Engineer will acknowledge receipt of Informational Submittals. Such Submittals include, but are not limited to:
1. Qualifications Data.
  2. Certificates.
  3. Test Reports.
  4. Manufacturer's Instructions.
  5. Maintenance Data.
  6. Field Reports.
- C. Delegated-Design Submittals: Review of Delegated-Design Submittals by Architect/Engineer shall not relieve Contractor of Contractor's sole responsibility for design and achieving specified performance.
- D. Submittals not required by the Contract Documents will be returned without being reviewed.
- E. Partial Submittals are not acceptable, will be considered non-responsive, and will be rejected.

END OF SECTION 01 33 00

## SECTION 01 42 00 – REFERENCES

### 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 provisions for references throughout the Contract Documents.

#### 1.3 DEFINITIONS

##### A. Abbreviations:

1. AASHTO - American Association of State Highway and Transportation Officials, 444 North Capitol Street, N.W., Suite 249, Washington, DC 20001.
2. ACI - American Concrete Institute, 38800 Country Club Dr., Farmington Hills, MI 48331.
3. AISC - American Institute of Steel Construction, Inc., One East Wacker Dr., Suite 700, Chicago, IL 60601-1802.
4. AITC - American Institute of Timber Construction, 7012 S. Revere Pkwy., Suite 140, Centennial, CO 80112.
5. ANSI - American National Standards Institute, 25 West 43rd St., 4th Floor, New York, NY 10036.
6. APA - American Plywood Association, 7011 S. 19th Street, Tacoma, WA 98466-5333.
7. ASTM - American Society for Testing and Materials, 100 Barr Harbor Dr., West Conshohocken, PA 19428-2959.
8. AWS - American Welding Society, Inc., 550 N.W. LeJeune Road, Miami, FL 33126.
9. AWWA - American Water Works Association, 6666 West Quincy Avenue, Denver, CO 80235.
10. CPA – Composite Panel Association, 19465 Deerfield Avenue, Suite 306, Leesburg, VA 20176.
11. CRSI - Concrete Reinforcing Steel Institute, 933 Plum Grove Road, Schaumburg, IL 60173-4758.
12. EGLE - Michigan Department of Environment, Great Lakes and Energy, 525 West Allegan Street, P.O. Box 30473, Lansing, MI 48909-7973.
13. MDNR - Michigan Department of Natural Resources, 530 West Allegan Street, P.O. Box 30028, Lansing, MI 48909.
14. MDOT - Michigan Department of Transportation, 425 West Ottawa Street, P.O. Box 30050, Lansing, MI 48909.
15. MDCH - Michigan Department of Community Health, 201 Townsend Street, Lansing, MI 48913.
16. MIOSHA - Michigan Department of Licensing and Regulatory Affairs, Michigan Occupational and Health Administration, State Secondary Complex, 7150 Harris Drive, P.O. Box 30643, Lansing, MI 48909-8143.
17. NCMA - National Concrete Masonry Association, 13750 Sunrise Valley Drive, Herndon, VA 20171-4662.
18. NEC - National Electrical Code (see NFPA 70).
19. NEMA - National Electrical Manufacturers' Association, 1300 N. 17th Street N.W., Suite 1752, Rosslyn, VA 22209.
20. NFPA - National Fire Protection Association, One Batterymarch Park, Quincy, MA 02169-7471.
21. PCI - Precast Concrete Institute, 200 West Adams, Suite 2100, Chicago, IL 60606.
22. SDI - Steel Deck Institute, P.O. Box 25, Fox River Grove, IL 60021.
23. SJI - Steel Joist Institute, 234 West Cheves Street, Florence, SC 29501.
24. UL - Underwriters' Laboratories, Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.

#### 1.4 REFERENCES

- A. The provisions of the Contract Documents shall govern over any conflicting provisions of the referenced documents.
- B. The provisions of laws and regulations shall govern over any conflicting provisions of the referenced documents.

- C. Comply with the referenced document that is in effect as of the Bid date, except when a specific date is specified.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

Not used.

END OF SECTION 01 42 00

## SECTION 01 45 34 – SPECIAL INSPECTIONS AND TESTS

### 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 provisions for special inspections as follows and includes the Statement of Special Inspections.
  - 1. Special inspections of structures.
  - 2. Special inspections within structures.
  - 3. Special inspections of underground components within 5-feet outside of the footprints of structures.
- B. Special inspection services for which Owner will contract and pay directly and will be performed by a special inspector or inspectors selected by Owner:
  - 1. Steel construction.
  - 2. Concrete construction.
  - 3. Masonry construction.
  - 4. Soils.
  - 5. Fire-resistant penetrations and joints.
  - 6. Travel expense of the special inspector.
- C. Include the following testing, special inspections and certifications in the Contractor's Base Bid:
  - 1. Inspections and tests required by codes or ordinances or by an authority having jurisdiction and made by a legally constituted authority.
  - 2. Structural testing and qualification for seismic resistance.
  - 3. Inspections, testing services and certifications including, but not limited to, the following:
    - a. Pipe leakage tests.
    - b. Welder certifications.
    - c. Structural steel yield strength mill tests.
    - d. Pipe material yield strength tests.
    - e. Manufacturer's certificate of compliance for high-strength bolts.
    - f. Manufacturer's certificate of compliance for weld filler metal.
    - g. Manufacturers' certification tests for cement.
    - h. Supplier's certification tests for fine and coarse aggregate.
    - i. Aggregate alkali reactivity testing.
    - j. Supplier's certification tests for bedding material.
    - k. Manufacturer's certified test reports of material, yield strength and gage for cold-formed steel deck and cold-formed metal framing.
    - l. Testing performed for the Contractor's convenience.
- D. Special Inspection of Load-Bearing Fabrications:
  - 1. Fabricators: Registered and approved in accordance with the Building Code so that special inspection of the fabrication of Project load-bearing components on the fabricator's premises will not be required.
- E. Owner Paid Items: Owner may elect to inspect or to employ either Engineer or a special inspector to inspect materials or systems on the Project other than those specified herein. The cost of this inspection will be paid for by Owner.
- F. Special inspection services are required to verify compliance with the Contract Documents and with the requirements of the Building Code. These services do not relieve Contractor of responsibility for verification of compliance with Contract Document requirements.



### 1.3 REFERENCES

- A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with the following:
1. ACI - American Concrete Institute:
    - a. 301 - Specification for Structural Concrete.
    - b. 318 - Building Code Requirements for Reinforced Concrete.
    - c. 530 - Building Code Requirements for Masonry Structures.
    - d. 530.1 - Specifications for Masonry Structures.
  2. AISC: 360 - Specification for Structural Steel Buildings.
  3. ASTM Standards:
    - a. C31 - Practice for Making and Curing Concrete Test Specimens in the Field.
    - b. C33 - Specification for Concrete Aggregates Including Appendix XI.
    - c. C39 - Test Method for Compressive Strength of Cylindrical Concrete Specimens.
    - d. C42 - Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
    - e. C138 - Test Method for Density (Unit Weight), Yield and Air Content (Gravimetric) of Concrete.
    - f. C140 - Test Methods of Sampling and Testing Concrete Masonry Units and Related Units.
    - g. C143 - Test Method for Slump of Hydraulic-Cement Concrete.
    - h. C157 - Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete.
    - i. C172 - Practice for Sampling Freshly Mixed Concrete.
    - j. C173 - Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
    - k. C192 - Practice for Making and Curing Concrete Test Specimens in the Laboratory.
    - l. C231 - Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
    - m. C295 - Guide for Petrographic Examination of Aggregates for Concrete.
    - n. C1019 - Test Method for Sampling and Testing Grout.
    - o. D698 - Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort.
    - p. D1556 - Test Method for Density and Unit Weight of Soil In Place by Sand-Cone Method.
    - q. D1557 - Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort.
    - r. D1586 - Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils.
    - s. D2166 - Test Method for Unconfined Compressive Strength of Cohesive Soil.
    - t. D2167 - Test Method for Density and Unit Weight of Soil In Place by the Rubber Balloon Method.
    - u. D2937 - Test Method for Density of Soil in Place by Drive-Cylinder Method.
    - v. D6938 - Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
    - w. E2174 - Practice for On-Site Inspection of Installed Firestops.
    - x. E2393 - Practice for On-Site Inspection of Installed Fire Resistive Joint Systems and Perimeter Fire Barriers.
  4. AWS:
    - a. D1.1 - Structural Welding Code - Steel.
    - b. D1.3 - Structural Welding Code - Sheet Steel.
    - c. D1.4 - Structural Welding Code - Reinforcing Steel.
  5. Michigan 2015 Building Code.
  6. RCSC - Research Council on Structural Connections: Specification for Structural Joints Using High-Strength Bolts.
  7. SDI - Steel Deck Institute: QA/QC – Quality Control and Quality Assurance for Installation of Steel Deck.
  8. MDOT:
    - a. Standard Specifications for Construction.
    - b. Density Testing and Inspection Manual.

### 1.4 DEFINITIONS

- A. Terms:
1. Building Code: The building code plus amendments, if any, legally adopted for the location in which the Project is located.
  2. Special Inspection: Inspection and testing as herein required of materials, installation, fabrication, erection or placement of components and connections requiring special expertise of one or more approved special inspectors in order to ensure compliance with the Building Code and the Contract Documents.
  3. Testing Agency; Independent Testing Agency: Special inspector.

## 1.5 PERFORMANCE REQUIREMENTS

- A. Special Inspector Qualifications:
1. Qualified in accordance with the Building Code and by local building official.
  2. Objective, competent and independent from the contractor performing the work to be inspected.
  3. Familiar with Building Code requirements for special inspections.
  4. Having adequate equipment, periodically calibrated as required, to perform the special inspections.
  5. Employing experienced personnel educated in conducting, supervising and evaluating special inspections similar in complexity to that required for the Project.
  6. Weld Inspectors: Certified in accordance with AWS D1.1, D1.3, D1.4 and D1.8, as applicable.
  7. Submission of Qualifications:
    - a. Special Inspector: Provide to the building official written documentation as required to demonstrate competence, objectivity and experience or training.
    - b. Disclose possible conflicts of interest.
- B. Perform special inspections in accordance with:
1. Laws and Regulations.
  2. Reference procedures and requirements.
  3. Building Code.
  4. Contract Documents.
  5. Manufacturer's requirements, as applicable.
  6. Reviewed submittals for the Project, as applicable.

## 1.6 REINSPECTION COSTS

- A. Reinspection:
1. When initial special inspections of items except soil compaction indicate noncompliance with the Contract Documents, subsequent special inspections occasioned by the noncompliance shall be performed by the same special inspection agency, and the costs thereof will be deducted by the Owner from the Contract Sum.
  2. Soil Compaction:
    - a. The first retesting of soil compaction shall be paid for in accordance with the provisions of the Contract Documents.
    - b. The second and subsequent retesting for soil compaction due to noncompliance with the Contract Documents shall be performed by the same special inspection agency, and the costs thereof will be deducted by the Owner from the Contract Sum.
- B. Uncovering Costs: Paid for as described in the General Conditions.

## 1.7 REPORTS AND SUBMISSIONS

- A. Special Inspection Reports:
1. Special Inspector: Keep records of special inspections in accordance with the Building Code.
  2. Records: Indicate that work inspected was or was not completed in conformance with the Contract Documents.
  3. Report and reinspect non-conformances until they are in conformance with the Contract Documents.
  4. Final Report:
    - a. Prepare and submit a final report at the completion of the special inspections.
    - b. Document the completion of specified special inspections and correction of discrepancies.
    - c. Submit as specified for inspection reports.
  5. Provide typed electronic copies of reports to:
    - a. Engineer.
    - b. Contractor.
    - c. Building official.
  6. Discrepancies: Bring to immediate attention of Contractor, and, if not corrected, to attention of Engineer and building official.

## 1.8 SCHEDULES FOR SPECIAL INSPECTIONS

- A. Establishing Schedule: By advance discussion between special inspector and Contractor, determine the time required to perform special inspection and to issue findings.
- B. Revising Schedule: When changes of construction schedule are necessary during construction, coordinate such changes of schedule with the special inspector.
- C. Adherence to Schedule: When the special inspector is ready according to the determined schedule, but is prevented from performing special inspection due to incompleteness of the Work, extra costs attributable to the delay may be charged to Contractor and shall not be borne by Owner.

## 1.9 CONTRACTOR'S DUTIES

- A. Cooperate with Special Inspector:
  - 1. Schedule the Work so that special inspector is allowed a reasonable schedule and amount of time to access and view the components requiring special inspection before being obscured by subsequent construction.
  - 2. Notify special inspector 24 hours minimum prior to expected time when special inspection services will be required.
  - 3. Provide the following as necessary for special inspector to properly perform its functions:
    - a. Access to the Work.
    - b. Facilities for access to the Work.
    - c. Tools.
    - d. Storage.
    - e. Assistance as requested.
- B. Submission of Written Statements:
  - 1. To be submitted by each contractor responsible for construction of a main wind or seismic force resisting system, designated seismic system or a wind or seismic resisting component listed in the Statement of Special Inspections.
    - a. Submit to building official, Owner, and Engineer, prior to commencement of construction on the respective system or component.
    - b. Acknowledging awareness of the special inspections specified herein.
  - 2. Each fabricator, at the completion of their respective fabrication, shall submit a certificate of compliance to the building official and Engineer stating that the fabrication was performed in accordance with the Contract Documents.

## PART 2 - PRODUCTS

Not used.

## PART 3 - EXECUTION

### 3.1 STATEMENT OF SPECIAL INSPECTIONS

- A. Frequency of Special Inspections:
  - 1. The minimum frequency of the special inspections (periodic vs. continuous) shall be as indicated in the Building Code.
  - 2. Quality assurance inspections performed in accordance with standards referenced herein shall conform to the frequency requirements indicated in those standards.
- B. Steel Construction:
  - 1. Inspect and verify structural steel in accordance with the quality assurance requirements of AISC 360 and the Contract Documents.
  - 2. Steel Construction Other Than Structural Steel:
    - a. Inspect and verify cold formed steel floor and roof deck in accordance with the quality assurance inspection requirements of SDI QA/QC.

C. Concrete Construction:

1. Special Inspections:
  - a. Except for material testing, perform special inspections in accordance with Table 1705.3 of the Building Code and this Specification for all concrete except:
    - 1) Non structural slabs on grade.
  - b. Inspect and verify:
    - 1) Reinforcing steel and placement.
    - 2) Anchor rods prior to and during placing of concrete.
    - 3) Anchors post-installed in hardened concrete.
    - 4) Proper use of required design mix.
    - 5) Proper placement of concrete.
    - 6) Maintenance of specified curing techniques and temperatures.
    - 7) Concrete formwork for proper shape, location, and dimension.
2. Concrete Material Testing:
  - a. Perform material testing in accordance with Table 1705.3 of the Building Code and this Specification for all concrete.
  - b. Point of sampling and the method of securing the Samples:
    - 1) Determined by special inspector.
    - 2) In accordance with ASTM C172.
  - c. Slump Tests:
    - 1) Perform slump tests in accordance with ASTM C143.
    - 2) Perform one slump test on the Site for each 10 cubic yards of concrete.
    - 3) At Engineer's request, also perform slump tests at batch plant before adding water reducer.
    - 4) Perform more slump tests if deemed necessary by Engineer.
  - d. Perform 1 air-entraining test in accordance with ASTM C231 or C173 for each truckload or every 10 yards of concrete placed, whichever is more frequent.
  - e. Test the concrete unit weight in accordance with ASTM C138 or C567, as applicable.
  - f. Test the air content and fresh concrete temperature of each set of concrete cylinders.
  - g. Concrete Cylinder Testing:
    - 1) In accordance with ASTM C31 and C39.
    - 2) Take concrete cylinder Samples as follows:
      - a) Once each day a given class of concrete is placed, nor less than
      - b) Once for each 150 cubic yards (or fraction thereof) of each class of concrete placed each day, nor less than
      - c) Once for each 5,000 square feet of slab or wall surface area placed each day.
    - 3) Concrete cylinder Sample shall consist of a minimum of 4 cylinders.
      - a) Make standard 6x12 cylinders, except that for concrete mixes with 1-inch or smaller coarse aggregate, 4x8 cylinders may be used.
      - b) Contractor shall be responsible for having additional pairs of cylinders taken and tested, if required to demonstrate adequate concrete strengths at ages earlier than 28 days if Contractor's schedule requires form removal from load-bearing concrete prior to 28 days.
    - 4) Handle cylinders carefully.
    - 5) On Site Storage:
      - a) 12 hours, minimum, 48 hours maximum.
      - b) At a temperature range of 60 to 80 degrees F and in a moist environment.
      - c) Shielded from direct sunlight and radiant heat.
      - d) The Contractor shall construct heated or water bath enclosures, as applicable, if conditions require.
      - e) Cylinders Samples taken to establish adequate strength for form removal earlier than 28-days shall be cured in locations that represent the conditions under which the structural concrete will be cured.
    - 6) Laboratory Curing:
      - a) For duration of curing after on Site storage.
      - b) Does not include cylinders taken to establish adequate strength for form removal earlier than 28-days.
    - 7) Test 1 of the cylinders at 7 days and 2 cylinders at 28 days. Save 1 cylinder as a spare.
    - 8) Acceptance and evaluation of the concrete shall be based on ACI 301.

- D. Masonry Construction:
1. Inspect and verify masonry in accordance with the quality assurance requirements of TMS 402/ACI 530/ASCE 5, TMS 602/ACI 530.1/ASCE 6 and the Contract Documents.
    - a. In addition, also inspect and verify:
      - 1) Anchor rods prior to and during placing of masonry.
      - 2) Anchors post-installed in hardened masonry.
    - b. Verification of masonry compressive strength  $f_m$  shall follow the provisions for the unit strength method.
    - c. Comply with Level B special inspection.
- E. Soils:
1. Inspect and verify in accordance with Table 1705.6 of the Building Code and this Specification.
  2. Inspect and verify:
    - a. Soil Below Shallow Foundations:
      - 1) Verify materials and compaction are suitable to support the structures at the design soil bearing value indicated on the Drawings with acceptable anticipated settlement.
    - b. Excavations are extended to proper depth and reached proper material.
    - c. Classification of structure fill and backfill material.
    - d. Classification of utility backfill material.
    - e. Use of proper fill and backfill materials, lift thicknesses and compaction.
    - f. Prior to placement of fill, subgrade material and preparation, and subgrade compaction.
    - g. Proof-Rolling:
      - 1) Witness proof-rolling of exposed subgrade of structure footprint.
        - a) Contractor shall provide heavy rubber tired truck and labor for proof-rolling.
      - 2) Report to Engineer and Contractor areas of subgrade requiring compaction or replacement.
    - h. Minimum Frequency of Soil Compaction Verification:
      - 1) Within Footprint of Structures:
        - a) One test per 1,000 square feet of subgrade for each layer of fill.
        - b) One test per 50 feet of utility trench for each layer of fill.
    - i. Perform more frequent testing when necessary because of Site conditions.
- F. Fire-Resistant Penetrations and Joints:
1. Perform inspections of penetration firestops in accordance with ASTM E2174 to verify the firestop is appropriate for the application and that it has been installed in conformance with its listing.
  2. Perform inspections of fire resistant joint systems in accordance with ASTM E2393 to verify the joint system is appropriate for the application and that it has been installed in conformance with its listing.

END OF SECTION 01 45 34

## SECTION 01 50 00 – TEMPORARY FACILITIES AND CONTROLS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. This Section includes the furnishing and installation of construction facilities as follows:
  - 1. Temporary Utilities: Water, electricity, and telephone.
  - 2. Contractor's field office.
  - 3. Sanitary facilities.
  - 4. Temporary heat.
  - 5. Enclosures such as tarpaulins, barricades and canopies.
  - 6. Storage areas.

#### 1.3 FIELD OFFICE AND STORAGE AREAS

- A. Locations: Specific storage locations within the general areas:
  - 1. Carefully coordinate with Owner.
  - 2. Subject to approval of Owner.
- B. Protection and Restoration:
  - 1. Protect trees and shrubs in the storage areas.
  - 2. Replace grass and other vegetation disturbed or damaged in the storage areas.
  - 3. Take reasonable means to prevent spillage of fuel, oil, chemicals and similar materials.
  - 4. Clean up spills and, if necessary, remove soil and replace with uncontaminated soil so as to allow vegetation to be quickly reestablished.
  - 5. Provide secondary containment for storage of hazardous materials, as required by governing authorities or agencies.
- C. Cleaning: Keep storage areas clean in accordance with Division 01 Section "Cleaning and Waste Management."
- D. Storage: Maintain in accordance with Division 01 Section "Product Storage and Handling Requirements."

### PART 2 - PRODUCTS

#### 2.1 MATERIALS

- A. General:
  - 1. New or used.
  - 2. Adequate in capacity for the required usage.
  - 3. Provide safe conditions.
  - 4. Comply with requirements of applicable codes and standards.

#### 2.2 UTILITIES

- A. Temporary Utilities:
  - 1. Equipment Testing:
    - a. Owner will pay utility charges for all power, water and other utilities.
    - b. Furnish, install, remove and pay for associated temporary equipment, piping, pumps, fuel, power distribution, and connections.

2. Water:
  - a. Owner will pay for water usage charges.
  - b. Furnish, install, remove and pay for all temporary piping, water meters, equipment and connections.
  - c. Obtain water by connection to Owner's existing water system.
  - d. Coordinate connection location with Owner.
3. Electricity:
  - a. Owner will pay for electrical usage charges for connections through Owner's service. Contractor shall pay for all costs associated with connecting to the Owner's service. Temporary service connection directly to DTE shall be paid by Contractor including usage charges.
  - b. Furnish, install, remove and pay for all temporary wiring, equipment switches, panels, connections and transformers.
  - c. Furnish, install, remove, and pay for area distribution boxes so located that power and artificial lighting are located at all points where required by the Work.
  - d. Obtain electrical power by connecting to Owner's existing system.
  - e. Coordinate connection location with Owner and DTE.
4. Construction Telephones:
  - a. Arrange for installation and removal of and pay for temporary telephones.
  - b. Pay for local telephone usage charges and Contractor's long distance usage charges.
  - c. Maintain construction telephones in Contractor's field office.
5. Temporary Sewer:
  - a. Furnish and install all necessary sumps, pumps and piping.
  - b. After completion of the Work, remove all such temporary items.
  - c. Coordinate connection location with Owner.

### 2.3 FIELD OFFICES

- A. Contractor's Field Office:
  1. Contractor's field office shall have at least 1 outside door.
  2. Pay for all telephone charges.

### 2.4 SANITARY FACILITIES

- A. Furnish and install all required temporary, portable toilet facilities for use by all contractor's workers; comply with all minimum requirements of the Health Department or other public agency having jurisdiction; maintain in a sanitary condition at all times. Use of Owner's sanitary facilities is not allowed.

### 2.5 CONSTRUCTION HEATING

- A. General:
  1. All heating required during the progress of the Work, prior to the installation of the permanent heating system, shall be classified "temporary heat".
  2. Prior to the installation of permanent heating equipment, furnish approved heaters and fuel as required.
  3. Keep equipment and surroundings in clean, safe condition.
  4. Pay all fuel bills for heat.
- B. Temperatures:
  1. Except as otherwise called for, a minimum temperature of 50 degrees F and a maximum temperature of 75 degrees F in the building shall be maintained during working hours and above freezing at all other times.
  2. See requirements of various other Sections of these Specifications for minimum temperature to be maintained for the application of work under the various trades.

### 2.6 OTHER TEMPORARY CONSTRUCTION FACILITIES

- A. Furnish, install and maintain all other temporary construction facilities necessary for proper completion of the Work.

### PART 3 - EXECUTION

#### 3.1 GENERAL

- A. Comply with applicable requirements specified in:
  - 1. Division 22 - Plumbing.
  - 2. Division 23 - Heating, Ventilating, and Air Conditioning.
  - 3. Division 26 - Electrical.
  - 4. Local Building Code.
- B. Maintain and operate systems to ensure continuous service.
- C. Modify and extend systems as Work progress requires.

#### 3.2 TEMPORARY CONTROLS

- A. Traffic Control:
  - 1. Provide adequate warning lights, signs, barricades and flagmen; take all necessary precautions for the protection of the Work, and the safety of the general public.
  - 2. Lights, signs and barricades shall conform to the Michigan Manual of Uniform Traffic Control Devices.
- B. Detours:
  - 1. Shall be approved by Owner and highway authority having jurisdiction prior to closing any road.
  - 2. Contractor shall secure above approvals and comply with all conditions thereof at Contractor's expense.

#### 3.3 REMOVAL

- A. Maintain all temporary facilities and controls as long as needed for the safe and proper completion of the Work. Remove all such temporary facilities and controls as rapidly as progress of the Work will permit.

END OF SECTION 01 50 00



## SECTION 01 66 00 – PRODUCT STORAGE AND HANDLING REQUIREMENTS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. This Section includes provisions for the storage and protection of Products.

#### 1.3 STORAGE AND PROTECTION

- A. Storage:
  - 1. Maintain ample way for foot traffic at all times.
  - 2. Repair or replace property damaged by reason of storing of material at no additional cost to Owner.
  - 3. Packaged Materials:
    - a. Delivered in original, unopened containers.
    - b. Stored until ready for use.
  - 4. Materials shall meet the requirements of these Specifications at the time that they are used in the Work.
  - 5. Store Products in accordance with Manufacturer's instructions.
- B. Protection:
  - 1. Use all means necessary to protect the:
    - a. Products of every Section before, during and after installation.
    - b. Installed work and materials of all trades.
  - 2. All materials shall be delivered, stored and handled to prevent:
    - a. The inclusion of foreign materials.
    - b. Damage by water, breakage or other causes.
  - 3. Provide weathertight storage sheds with raised floors as may be required to adequately protect those materials and Products stored on the Site which may require protection from damage by the elements.
- C. Replacements: In the event of damage, immediately make all repairs and replacements necessary to the approval of Consulting Engineer and at no additional cost to Owner.

### PART 2 - PRODUCTS

Not used.

### PART 3 - EXECUTION

Not used.

END OF SECTION 01 66 00

## SECTION 01 71 23 – FIELD ENGINEERING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. This Section includes provisions for the layout of the Work to be performed by the Contractor.

#### 1.3 QUALITY ASSURANCE

- A. Qualifications: Layout of facility corners and Sitework shall be by a Registered Land Surveyor.

#### 1.4 LAYOUT OF THE WORK

- A. Reference Points:
  - 1. Locate and protect reference points prior to beginning work.
  - 2. Pay for replacement of reference points if disturbed by Contractor's operations.
- B. Lay out all components, including but not limited to:
  - 1. Walls.
  - 2. Utilities.
  - 3. Manholes, catch basins and buried pipe.
  - 4. Paved areas and roads.
  - 5. Floors and slabs.
  - 6. Foundations.
  - 7. Equipment.
  - 8. Grades and elevations.
- C. Adjustments for Equipment:
  - 1. Adjust dimensions for the specific equipment to be installed.
  - 2. Coordinate the adjustments with all trades.
  - 3. Report the adjustments to Architect/Engineer prior to starting the work.
- D. Subcontractor Responsibilities:
  - 1. Require Subcontractor to:
    - a. Field verify all dimensions relating to Subcontractor's work prior to starting work.
    - b. Field verify that the components to which Subcontractor's work will be applied are in acceptable condition to receive Subcontractor's work.
  - 2. Report all errors or inconsistencies to Architect/Engineer.
  - 3. Subcontractor: Starting of work indicates acceptance of condition of components to which work will be applied.

#### 1.5 FIELD VERIFICATION

- A. Shop Drawings:
  - 1. Verify or correct Shop Drawing dimensions with field measurements prior to submission.
  - 2. If requested, assist Architect/Engineer in rechecking field measurements.

### PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

Not used.

END OF SECTION 01 71 23

## SECTION 01 73 29 – CUTTING AND PATCHING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. This Section includes provisions for cutting and patching work.
- B. Requirements:
  - 1. Cutting and patching may be described in various Sections of these Specifications
  - 2. Execute cutting, including excavating and filling, or patching of work required to:
    - a. Make several parts fit properly.
    - b. Uncover work to provide for installation of ill-timed work.
    - c. Remove and replace defective work.
    - d. Remove and replace work not conforming to the requirements of the Contract Documents.
    - e. Remove Samples of the installed work as specified for testing.
    - f. Install specified work in existing construction.
- C. Requirements Upon Architect/Engineer's Instructions: In addition to Contract requirements, upon written instruction of Architect/Engineer:
  - 1. Uncover work to provide for Architect/Engineer's observation of covered work.
  - 2. Remove Samples of installed materials for testing.
  - 3. Remove work to provide for alteration of existing work.
- D. Protection of Work:
  - 1. Do not endanger any work by cutting or altering the work or any part of it.
  - 2. Do not cut or alter the work of another trade without written consent of Architect/Engineer.

#### 1.3 SUBMITTALS

- A. Written Notice:
  - 1. Prior to cutting which may affect the structural integrity of the Project or the work of another trade, submit written notice to Architect/Engineer requesting consent to proceed with cutting.
  - 2. Required Information:
    - a. Identification of Project.
    - b. Description of all related defective work.
    - c. Necessity for cutting.
    - d. Affect on other work or on the structural integrity of the Project.
    - e. Description of the proposed work including:
      - 1) Scope of cutting and patching.
      - 2) Subcontractor and trades to execute work.
      - 3) Products proposed to be used.
      - 4) Extent of refinishing.
    - f. Alternatives to cutting and patching.
    - g. Designation of party responsible for the cost of cutting and patching.
- B. Changes of Materials or Methods: Should conditions of the Work, or the schedule, indicate change of materials or methods, submit a written recommendation to Architect/Engineer including:
  - 1. Conditions indicating the change.
  - 2. Recommendations for alternative materials or methods.
  - 3. Submittals as required for substitutions.
- C. Uncovered Work: Submit written notice to Architect/Engineer designating the time work will be uncovered to provide for observation.

#### 1.4 DIVISION OF WORK

##### A. Work:

1. In accordance with the General Conditions, Contractor is responsible for dividing the Work among the Subcontractors and Suppliers and for delineating the work to be performed by specific trades.
2. The following are suggestions as to how the Work may be divided. This is not a complete list of all the Work:
  - a. Each trade shall be financially responsible for all cutting and patching for sleeves, penetrations and installation of isolated components as necessary for its work unless herein specifically stated to the contrary.
  - b. On renovation projects, Contractor shall cut and patch walls, floors, ceilings to allow for continuous runs of recessed utilities.
  - c. All patching shall be done by the trade whose work is damaged.
  - d. Any cost caused by defective or ill-timed work shall be borne by the party responsible.
  - e. Each trade shall do all fitting of its own work as required to make its several components fit together or to receive the work of other contractors.
  - f. Holes cut in exterior walls or roofs for installation of mechanical or electrical equipment shall be waterproofed. If existing roofing is to remain, obtain and submit to Owner original roofing manufacturer's approval and warranty on new roof penetrations and where removing existing roof penetrations and curbs.

#### PART 2 - PRODUCTS

##### 2.1 MATERIALS

- A. All materials and workmanship shall conform to the requirements of other Sections of the Specifications. Where no materials are specified in these specifications, use materials of an equivalent type, quality, and size to match those existing in other areas of the facility. If none exist, use materials and workmanship recognized as of the highest quality in the industry. Obtain Engineer's review of all such material and workmanship.

#### PART 3 - EXECUTION

##### 3.1 INSPECTION

- A. Existing Conditions: Inspect existing conditions of the Work, including elements subject to movement or damage during cutting and patching or excavating and backfilling.
- B. Uncovered Work: After uncovering work, inspect conditions affecting the installation of new Products.

##### 3.2 PREPARATION

- A. Shoring and Bracing: Provide shoring, bracing and support as required to maintain structural integrity of the Project.
- B. Protection: Provide protection for other portions of the Project and provide protection from the elements.

##### 3.3 PERFORMANCE

- A. Adjustments to Products: Execute fitting and adjustments of Products to provide finished installation.
- B. Refinishing:
  1. Prepare existing surfaces for finishes by scraping, sanding, filling, acid etching, and sand blasting to ensure bonding and a smooth finish.
  2. Refinish entire surfaces as necessary to provide an even finish.
  3. Refinish continuous surfaces to the nearest intersection.
  4. Refinish entire assemblies.

3.4 CLEANING

- A. Clean materials installed under this Section in accordance with Division 01 Section "Cleaning and Waste Management."

END OF SECTION 01 73 29

## SECTION 01 74 00 – CLEANING AND WASTE MANAGEMENT

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. This Section includes provisions for maintaining structures and the Site in a standard of cleanliness.
- B. Related Sections: In addition to standards described in this Section, comply with requirements for cleaning as described in various other Sections of these Specifications.

#### 1.3 QUALITY ASSURANCE

- A. Inspection:
  - 1. Daily and more often if necessary.
  - 2. Conduct inspections to verify that requirements of cleanliness are being met.

#### 1.4 DELIVERY, STORAGE AND HANDLING

- A. Hazards Control:
  - 1. Volatile Wastes:
    - a. Store in covered metal containers.
    - b. Remove from premises daily.
    - c. Provide secondary containment for storage of hazardous materials, as required by governing authorities or agencies.
  - 2. Prevent accumulation of wastes which create hazardous conditions.
  - 3. Provide adequate ventilation during use of volatile or noxious substances.

#### 1.5 PROJECT CONDITIONS

- A. Cleaning and Disposal:
  - 1. Conduct operations to comply with local ordinances and anti-pollution laws.
  - 2. Not Allowed:
    - a. Burning or burying of rubbish or waste materials on Site.
    - b. Disposal of volatile wastes in storm or sanitary sewers: Volatile wastes include, but are not limited to, mineral spirits, oil or paint thinner.
    - c. Disposal of wastes into streams or waterways.

### PART 2 - PRODUCTS

#### 2.1 MATERIALS AND EQUIPMENT

- A. Compatibility:
  - 1. Compatible with the surface being cleaned.
  - 2. Recommended by the Manufacturer of the material being cleaned.
  - 3. As reviewed by Engineer or Consulting Engineer.

## PART 3 - EXECUTION

### 3.1 PROGRESS CLEANING

#### A. General:

1. Store Materials:
  - a. In an orderly arrangement allowing maximum access.
  - b. To allow unimpeded drainage and traffic.
  - c. Provide for the required protection of materials.
2. Do not allow accumulation of scrap, debris, waste material and other items not required for construction of the Work.
  - a. Remove from Site at least each week and more often if necessary.
  - b. Provide adequate storage for materials awaiting removal.
3. Observe requirements for fire protection and protection of the environment.

#### B. Site:

1. Daily, and more often if necessary:
  - a. Inspect the Site.
  - b. Pick up scrap, debris and waste material; remove such items to the place designated for their storage.
2. Weekly, and more often if necessary:
  - a. Inspect arrangements of materials stored on Site.
  - b. Restack or otherwise service arrangements to meet the requirements of paragraph 3.1.A.1 above.
3. At all times maintain the Site in a neat and orderly condition which meets the approval of Consulting Engineer and Owner.
4. Paved Surfaces: Keep clean.
5. Dust Control:
  - a. Control dust on or near the Work by the application of water or other approved means.
  - b. If Contractor fails to correct unsatisfactory conditions with 24 hours after due notification:
    - 1) Owner may arrange for such work to be performed by other means.
    - 2) Pay costs.

#### C. Buildings, Tanks, and Other Structures:

1. Weekly, and more often if necessary:
  - a. Inspect.
  - b. Pick up scrap, debris and waste material; remove such items to the place designated for their storage.
  - c. Sweep interior spaces clean. Clean shall be defined to be free from dust and other material capable of being removed by reasonable diligence using a hand-held broom.
2. Preparation for installation of succeeding material:
  - a. Clean the building, tank or other structure or pertinent portion thereof:
    - 1) To the degree of cleanliness recommended by the Manufacturer of the succeeding material.
    - 2) Using equipment and materials required to achieve the required cleanliness.
3. After installation of finish floor material:
  - a. Clean the finish floor daily at all times while work is being performed in the space in which finish materials have been installed.
    - 1) Clean as used above shall be defined to be free from all foreign material which, in the opinion of Engineer, may be injurious to the finish floor material.
4. Schedule cleaning operations so that dust and other contaminants resulting from cleaning operations will not fall on wet, recently painted surfaces.

### 3.2 FINAL CLEANING

- #### A. Definitions for Clean: The level of cleanliness generally provided by commercial building maintenance subcontractors using commercial quality building maintenance equipment and materials.

#### B. Prior to Completion of the Work:

1. Remove from the Site all tools, surplus materials, equipment, scrap, debris and waste.
2. Conduct final progress cleaning as described in Article 3.1 above.



- C. Site:
  - 1. Unless otherwise specifically directed by Engineer:
    - a. Hose down paved areas on Site and public sidewalks directly adjacent to the Site.
    - b. Rake clean other surfaces of the grounds.
  - 2. Remove resultant debris.
  
- D. Buildings, Tanks and Other Structures:
  - 1. Exterior:
    - a. Visually inspect exterior surfaces.
    - b. Remove traces of soil, waste material, smudges and other foreign matter.
    - c. Remove traces of splashed materials from adjacent surfaces.
    - d. If necessary to achieve a uniform degree of exterior cleanliness, hose down the exterior surface.
    - e. In the event of stubborn stains not removable with water, Engineer may require light sandblasting or other cleaning at no additional cost to Owner.
  - 2. Interior:
    - a. Visually inspect interior surfaces.
    - b. Remove traces of soil, waste material, smudges and other foreign matter.
    - c. Remove traces of splashed materials from adjacent surfaces.
    - d. Remove paint droppings, spots, stains and dirt from finished surfaces using only the specified cleaning materials and equipment.
  - 3. Glass: Clean glass inside and outside.
  - 4. Polished Surfaces: To surfaces requiring the routine application of buffed polish, apply the specified polish as recommended by the Manufacturer of the material being polished.
  
- E. Timing: Schedule final cleaning as approved by Engineer to enable Owner to accept a completely clean Project.

### 3.3 OWNER OCCUPANCY PRIOR TO SUBSTANTIAL COMPLETION AND ACCEPTANCE

- A. If Owner occupies the Work, or a portion of the Work, prior to Substantial Completion and acceptance, then the responsibilities for interim and final cleaning shall be determined by Engineer and Consulting Engineer in accordance with the Contract Documents.

END OF SECTION 01 74 00

## SECTION 01 75 00 – STARTING AND ADJUSTING

### 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 provisions for the facility start-up and demonstration of the systems as follows:
  - 1. Equipment.
  - 2. Mechanical systems.

#### 1.3 SUBMITTALS

- A. Preliminary Schedules:
  - 1. Submit 2 weeks prior to earliest proposed date.
  - 2. List time and date for the following for each system:
    - a. Start-up.
    - b. Demonstration.
- B. Completion Reports:
  - 1. Submit within 1 week after each system demonstration.
  - 2. List time, date and persons present for the following for each system:
    - a. Start-up.
    - b. Demonstration.
  - 3. Include [ Manufacturer's representative's ] report indicating:
    - a. Approval of installation.
    - b. Satisfactory start-up.
    - c. Functioning correctly.
  - 4. Indicate that demonstration and instructions were satisfactorily completed.

#### 1.4 QUALITY CONTROL

- A. Manufacturer's Field Services:
  - 1. Provide when required by individual Section.
  - 2. Provide the following services except where indicated otherwise in individual Sections.
    - a. Inspect, check and approve system installation.
    - b. Supervise system start-up.
    - c. Provide written report indicating that system:
      - 1) Has been properly installed and lubricated.
      - 2) Is in accurate alignment.
      - 3) Is free from undue stress imposed by connecting lines or anchor bolts.
      - 4) Has been satisfactorily operated under full load conditions.
    - d. Demonstrate operation of system to the Owner's personnel.
    - e. Instruct the Owner's personnel on operation and maintenance of system.

#### 1.5 PROJECT CONDITIONS

- A. Verify that:
  - 1. Excess packing and shipping bolts have been removed.
  - 2. Interdependent systems have been checked and are operational.

#### 1.6 CORRECTION PERIOD

- A. Provide periodic continuing warranty services as necessary to ensure proper functioning of mechanical systems after occupancy of the Project, and for a period of 1 year after date of Substantial Completion.

## PART 2 - PRODUCTS

Not used.

## PART 3 - EXECUTION

### 3.1 STARTING OF SYSTEMS

- A. Inspection:
  - 1. Verify that Project conditions comply with requirements.
  - 2. Verify that status of Work meets requirements for starting of systems.
  
- B. Preparation:
  - 1. Coordinate sequence for start-up of various systems [ including Owner-provided equipment ].
  - 2. Notify the Architect 7 days prior to start-up of each system.
  - 3. Have at hand during entire start-up process:
    - a. Contract Documents.
    - b. Shop Drawings.
    - c. Product Data.
    - d. Operation and Maintenance Data.
  - 4. Verify that each piece of equipment has been checked for:
    - a. Proper lubrication.
    - b. Drive rotation.
    - c. Belt tension.
    - d. Control sequence.
    - e. Other conditions which may cause damage.
  - 5. Verify control systems are fully operational in automatic mode.
  - 6. Verify that tests, meter readings and specific electrical characteristics agree with those specified by electrical equipment Manufacturer.
  - 7. Bearings:
    - a. Inspect for cleanliness, clean and remove foreign materials.
    - b. Verify alignment.
    - c. Replace defective bearings and those which run rough or noisy.
    - d. Grease as necessary and in accordance with Manufacturer's recommendations.
  - 8. Drives:
    - a. Adjust tension in V-belt drives, and adjust vari-pitch sheaves and drives for proper equipment speed.
    - b. Adjust drives for alignment of sheaves and V-belts.
    - c. Clean, remove foreign materials before starting operation.
  - 9. Motors:
    - a. Check each motor for amperage comparison to nameplate value.
    - b. Correct conditions which produce excessive current flow and which exist due to equipment malfunction.
  - 10. Flanges:
    - a. Tighten flanges after system has been placed in operation.
    - b. Replace flange gaskets which show any sign of leakage after tightening.
  - 11. Screwed Joints:
    - a. Inspect screwed joints for leakage.
    - b. Promptly remake each joint which appears to be faulty; do not wait for rust to form.
    - c. Clean threads on both parts, apply compound and remake joints.
  - 12. Cleaning:
    - a. After system has been placed in operation, clean strainers, dirt pockets, orifices, valve seats and headers in fluid systems, to ensure being free of foreign materials.
    - b. Open steam traps and air vents; remove operating elements. Clean thoroughly, replace internal parts, and put back into operation.
    - c. Remove rust, scale and foreign materials from equipment and renew defaced surfaces.
  - 13. Draft Gages: Set and calibrate draft gages of air filters and other equipment.
  - 14. Fan Wheels:
    - a. Inspect fan wheels for clearance and balance.
    - b. Provide factory-authorized personnel for adjustment when needed.

15. Control Circuits:
  - a. Check each electrical control circuit to ensure that operation complies with Specifications and requirements to provide desired performance.
16. Pressure gages:
  - a. Inspect each pressure gage and thermometer for calibration.
  - b. Replace items which are defaced, broken or which read incorrectly.
17. Repair damaged insulation.
18. Venting and drainage:
  - a. Vent gases trapped in any part of systems.
  - b. Verify that liquids are drained from all parts of gas or air systems.
19. Leaks: Check piping for leaks at every joint and at every screwed, flanged or welded connection using "Leak-Tek" or other approved compound.

C. Startup:

1. Execute startup under supervision of responsible persons in accordance with Manufacturer's instructions.
2. Place equipment in operation in proper sequence.

### 3.2 SYSTEMS DEMONSTRATION

A. Preparation:

1. Verify That System:
  - a. Has been inspected and put in service.
  - b. Is fully operational.
2. Operation and Maintenance Manuals:
  - a. Completed.
  - b. Sufficient copies available for use in demonstrations and instructions.

B. Demonstrations and Instructions:

1. Demonstration Of and Instruction On Operation and Maintenance of System:
  - a. To the Owner's personnel.
  - b. Two weeks prior to Substantial Completion.
2. Equipment Requiring Seasonal Operation: Demonstrate within 6 months.
3. Instruction:
  - a. Operation and maintenance manual as basis.
  - b. Review contents of manual in detail.
  - c. Explain all aspects of operation and maintenance.
4. Demonstrate:
  - a. Start-up.
  - b. Operation.
  - c. Control.
  - d. Adjustment.
  - e. Troubleshooting.
  - f. Servicing.
  - g. Maintenance.
  - h. Shutdown.

### 3.3 PERFORMANCE TEST

A. Performance Test:

1. Test the entire Work, including all of its individual systems for 2 weeks before final payment will be made.
2. Make final tests in the presence of the Owner and the Architect.
3. If any part of the Work or equipment does not meet Specifications:
  - a. Correct the situation.
  - b. Obtain approval of the Architect before final payment is made.
4. Provide the personnel and bear all costs for correcting all malfunctions.
5. The Owner will provide operating personnel and utilities.

END OF SECTION 01 75 00

## SECTION 01 77 00 – CLOSEOUT PROCEDURES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. This Section includes the instructions for and the responsibilities of each party in contract closeout.
- B. Related Section includes Certificate of Substantial Completion.

#### 1.3 SUBSTANTIAL COMPLETION

- A. Contractor: When Contractor considers that the Work or any portion of the Work is ready for its intended use, Contractor shall submit:
  - 1. Written certification to Architect and Owner that the Work, or designated portion of the Work, is substantially complete.
  - 2. A list of major items to be completed or corrected.
  - 3. Request that Engineer issue a certificate of Substantial Completion.
- B. Architect/Engineer's Inspection: Architect/Engineer will make an inspection:
  - 1. Within 10 days after receipt of certification.
  - 2. Together with Owner and Contractor.
- C. Architect/Engineer's Determination of Substantial Completion:
  - 1. Should Architect/Engineer consider the Work or designated portion of the Work substantially complete, the following steps shall be taken:
    - a. Architect/Engineer shall prepare and submit to Contractor, a list of items to be completed or corrected as determined by the inspection.
    - b. Architect/Engineer will prepare and deliver to Owner:
      - 1) A tentative certificate of Substantial Completion.
      - 2) A tentative list of items to be completed or corrected before final payment.
    - c. Architect/Engineer will, within 14 days after delivery of tentative certificate to Owner, decide:
      - 1) Not Substantially Complete: Architect/Engineer will issue written notice to Contractor stating reasons.
      - 2) Substantially Complete: Architect/Engineer will issue definitive certificate of Substantial Completion to Owner and a revised list of items to be corrected or completed.
    - d. After receiving the definitive certificate from the Architect/Engineer, the Owner shall issue a letter of Substantial Completion to the Contractor.
  - 2. Should Architect/Engineer consider that the Work or designated portion of the Work is not substantially complete, the following steps shall be taken:
    - a. Architect/Engineer shall notify Contractor in writing stating Architect/Engineer's reasons.
    - b. Contractor shall complete the Work and send a second written notice to Architect/Engineer certifying that the Project, or designated portion of the Project, is substantially complete.
    - c. Architect/Engineer and Owner will reinspect the Work.
- D. Division of Responsibilities:
  - 1. Architect/Engineer:
    - a. At the time of delivery of tentative certificate of Substantial Completion.
    - b. Deliver to Owner and Contractor a written recommendation as to division of responsibilities pending final payment with respect to:
      - 1) Operation.
      - 2) Safety.
      - 3) Protection of the Work.
      - 4) Maintenance.

- 5) Heat.
- 6) Utilities.
- 7) Insurance.
- 8) Warranties.

#### 1.4 FINAL INSPECTION

- A. Contractor Certification: Prior to final inspection, Contractor shall submit written certification that:
  1. The Contract Documents have been reviewed.
  2. The Project has been inspected in compliance with the Contract Documents.
  3. Work has been completed in accordance with the Contract Documents.
  4. Equipment and systems have been tested in the presence of the Owner's representative and are operational.
  5. The Project is complete and ready for final inspection.
- B. Architect/Engineer's Inspection: The Architect/Engineer will make final inspection:
  1. Within 10 days after receipt of certification.
  2. Together with Owner and Contractor.
- C. Architect/Engineer's Determination of Final Completion:
  1. Should Architect/Engineer consider the Work complete and ready for final payment in accordance with the requirements of the Contract Documents, Architect/Engineer shall request Contractor to make Project closeout submittals.
  2. Should Architect/Engineer consider the Work not complete and ready for final payment:
    - a. Architect/Engineer shall notify Contractor in writing stating the reasons.
    - b. Contractor:
      - 1) Take immediate steps to remedy the stated deficiencies.
      - 2) Send a second written notice to Architect/Engineer certifying that the Work is complete.
    - c. Architect/Engineer and Owner will reinspect the Work.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Contractor:
  1. Provide closeout submittals as required in the Contract Documents.
  2. These submittals shall include, but not necessarily be limited to:
    - a. Project record documents.
    - b. Operation and maintenance manuals.
    - c. Guarantees.
    - d. Spare parts and maintenance materials.
    - e. Instruction in operation of all systems.

#### 1.6 EVIDENCE OF PAYMENTS AND RELEASE OF LIENS

- A. Affidavits:
  1. Submit with final Application for Payment an affidavit of payment of debts and release of claims.
  2. Affidavit shall include:
    - a. Contractor's and Subcontractors' unconditional release or waiver of lien.
    - b. Consent of surety of final payment.
- B. Execution: All submittals shall be duly executed before delivery to Architect/Engineer.

#### 1.7 FINAL ADJUSTMENT OF ACCOUNTS

- A. Final Statement: Submit a final statement of accounting, which reflects all adjustments, to Architect/Engineer. This statement shall contain the following:
  1. Original Contract Price.
  2. Additions and deductions.
  3. Total Contract Price as adjusted.
  4. Previous payments.
  5. Sum remaining due.

- B. Final Change Order: Engineer will prepare a final Change Order reflecting approved adjustments to the Contract Price not previously made by Change Orders.

1.8 FINAL APPLICATION FOR PAYMENT

- A. Contractor shall submit a final Application for Payment in accordance with the requirements of the Contract Documents.
- B. Disposition of Final Application for Payment:
  - 1. If the final Application for Payment and the Work are acceptable in accordance with the Contract Documents:
    - a. Architect/Engineer will, within 10 days after receipt of the Application for Payment:
      - 1) Submit to Owner a written recommendation for payment.
      - 2) Submit to Owner and Contractor a written notice that the Work is acceptable subject to the provisions of the General Conditions.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

Not used.

END OF SECTION 01 77 00

## SECTION 01 78 39 – PROJECT RECORD DOCUMENTS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. This Section includes procedures for the maintenance, recording and submittal of Project record documents.

#### 1.3 MAINTENANCE OF DOCUMENTS AND SAMPLES

- A. Storage:
  - 1. Store documents and Samples in Contractor's field office apart from documents used for construction.
  - 2. Provide files and racks for storage of documents.
  - 3. Provide locked cabinet or secure storage space for storage of Samples.
- B. Filing: File record documents in accordance with CSI Masterformat.
- C. Maintenance:
  - 1. Maintain documents in a clean, dry, legible condition and in good order.
  - 2. Do not use record documents for construction purposes.
- D. Availability: Make documents and Samples available at all times for inspection by Engineer.

#### 1.4 RECORDING

- A. Labeling: Label each document "PROJECT RECORD" in neat large printed letters.
- B. Recording:
  - 1. Record actual revisions to the Work.
  - 2. Record information concurrently with construction progress.
  - 3. Do not conceal any work until required information is recorded.
- C. Drawings:
  - 1. Legibly mark, with notes or graphic representations, to record actual construction.
    - a. Depths of various elements of foundation and buried piping in relation to approved datum.
    - b. Horizontal and vertical locations of Underground Facilities and appurtenances, referenced to permanent surface improvements.
    - c. Location of internal utilities and appurtenances concealed in the construction, referenced to visible and accessible features of the structure.
    - d. Field changes of dimension and detail.
    - e. Changes made by Field Order, Work Change Directive or Change Order.
    - f. Details not on original Contract Drawings.
  - 2. After Architect/Engineer's review of the record drawings, transfer all marks to a set of hard copy and electronic documents provided by Architect/Engineer.
- D. Specifications and Addenda:
  - 1. Legibly mark each Section to record:
    - a. Manufacturer, trade name, catalog number, and Supplier of each Product and item of equipment actually installed.
    - b. Changes made by Field Order, Work Change Directive or Change Order.



1.5 SUBMITTAL

- A. Delivery: At Contract closeout, deliver record documents to Architect/Engineer.
- B. Transmittal Letter:
  - 1. Accompany submittal with transmittal letter in duplicate, containing:
    - a. Date.
    - b. Project title and number.
    - c. Contractor's name and address.
    - d. Title and number of each Record Document.
    - e. Signature of Contractor or their authorized representative.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

Not used.

END OF SECTION 01 78 39

SECTION 01 91 13 – GENERAL COMMISSIONING REQUIREMENTS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Commissioning is a systematic process of ensuring that all building systems perform interactively according to the design intent and the Owner's operational needs.
- B. Commissioning during the construction phase is intended to achieve the following specific objectives:
  1. Verify that applicable equipment and systems are installed according to the manufacturer's recommendations and to industry accepted minimum standards and that they receive adequate operational checkout by installing contractors.
  2. Verify and document proper performance of equipment and systems.
- C. 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.
- D. Abbreviations: The following are common abbreviations used in the Commissioning Specifications and in the Commissioning Plan.

A/E	Architect and Design Engineers	HI&C Sub	HVAC Instrumentation and Controls Contractor
CC	Construction Checklist	FT	Functional Test
CM	Construction Manager	MC	Mechanical Contractor
Cx	Commissioning		
Cx Plan	Commissioning Plan	Subs	Subcontractors
CxA	Commissioning Authority	TAB Sub	Test, Adjust and Balance Contractor
EC	Electrical Contractor		

1.2 COORDINATION

- A. Commissioning Team: The members of the commissioning team consist of the Commissioning authority (CxA), the Owner, the Owner's Facility Manager, the designated commissioning representative of the Construction Management firm (CM), the architect and design engineers of record (A/E) (particularly the mechanical engineer), the Mechanical Contractor (MC), the Electrical Contractor (EC), the Test, Adjust, Balance Contractor (TAB Sub), the HVAC Instrumentation and Controls Contractor (HI&C Sub), and other installing subcontractors or suppliers of equipment.
- B. Scheduling. The CxA will work with the CM according to established protocols to schedule the commissioning activities. The CxA will provide sufficient notice to the CM for scheduling commissioning activities. The CM will integrate all commissioning activities into the master schedule. All parties will address scheduling problems and make necessary notifications in a timely manner.
- C. The CxA will provide the initial schedule of primary commissioning events at the commissioning kick-off meeting. As construction progresses more detailed schedules are developed by the CxA.

1.3 COMMISSIONING PROCESS

- A. Commissioning Plan.
  1. The Cx Plan is to be provided by the CxA and provides guidance in the execution of the commissioning process. An example Cx Plan is given below. Just after the commissioning kick-off meeting (see below) the CxA will update the plan, which is then considered the "final" plan, though it will continue to evolve and expand as the project progresses.
- B. Commissioning Process. The following narrative provides a brief overview of the typical commissioning tasks during construction and the general order in which they occur.
  1. Commissioning during construction begins with a kick-off meeting conducted by the CxA where the commissioning plan and commissioning process are reviewed with the commissioning team members.

2. Additional meetings will be required throughout construction, scheduled by the CxA in conjunction with the CM with necessary parties attending, to plan, coordinate, and schedule future activities and resolve problems.
3. The CxA, through the CM, may provide the HI&C Sub, MC, EC, and TAB Sub checklists to be filled out during construction.
  - a. The MC, EC, HI&C Sub, and TAB Sub fill out the construction checklists under their own direction and in accordance with the schedule requirements stated in the Cx Plan.
  - b. Completed construction checklists are submitted to the CM who provides copies to the CxA.
  - c. The CxA reviews the checklists and reports to the CM any deficiencies which need correction.
4. Equipment Start up:
  - a. Scheduled by the CM.
  - b. Start up documentation will include the commissioning start up checklist and the manufacturer's detailed start up documentation referred to above.
  - c. The CxA documents that the start up was completed according to the approved plans. .
5. Development of Functional Tests:
  - a. The CxA develops specific equipment and system functional test procedures.
  - b. The commissioning team members review the procedures and provide comment.
  - c. CxA incorporates comments as appropriate.
6. Review of Specified Test Reports (e.g., duct leakage, piping purity, flushing and cleaning, etc.):
  - a. For all systems/equipment being commissioned, the CM provides the CxA a schedule for submission of test results required by the specifications.
  - b. The CxA reviews test results and provides comment to the CM.
  - c. Items of noncompliance are corrected at the Contractor's expense and revised test results submitted for review.
7. Execution of Functional Tests:
  - a. Scheduled by the CM for the individual systems and equipment to be tested.
  - b. The functional test procedures are executed by the MC, EC, HI&C Sub, and TAB Sub as appropriate, under the direction of the CxA.
  - c. Items of noncompliance in material, installation, and operation are corrected and the system retested at the Contractor's expense.
  - d. The CxA may terminate testing and require retesting when non-compliant issues are found.
  - e. The Contractor shall conduct "systems readiness testing" of functional test steps on their own before functional test demonstrations with the CxA present.
  - f. Items of non-compliance in material, installation, and operation are corrected and the system retested at the Contractor's expense.
    - 1) Failed functional test demonstration steps that require retesting will result in a cost to the Contractor of USD \$1,250 per CxA day on site. These charges are to be reimbursed to the CxA.
8. Owner Training:
  - a. Unless specified otherwise, for each system the following topics shall be covered:
    - 1) Overview and description of the purpose of the system.
    - 2) System Troubleshooting: Description of diagnostic step by step procedures for determining the source of problems on the system level, review technical service manual in detail.
    - 3) Component Maintenance: Instruction of required procedures for weekly, monthly, and annual preventive checks and timely repairs to preserve system integrity.
    - 4) Component Troubleshooting: Descriptions of diagnostic procedures for determining the source of problems on the component level.
    - 5) Review of control drawings and schematics (have copies available for training session attendees).
    - 6) Demonstration of operation through complete cycles and full range of operation in all operating modes, including start up, loading, normal operation, unloading, shutdown, unoccupied operation, seasonal changeover, etc., as applicable.
    - 7) Integral Controls (Packaged): Programming, troubleshooting, alarms, manual operation.
    - 8) Programming, troubleshooting, alarms, manual operation, interface with integral controls.
    - 9) Interactions with other systems, operation during power outages and fire alarms.
    - 10) Relevant health and safety issues/concerns and special safety features.
    - 11) Energy conserving operation and strategies.
    - 12) All special issues to maintain warranty.
    - 13) Common troubleshooting issues and methods, BMS warnings and error messages, including using the system for diagnostics.

- 14) Service, Maintenance, and Preventive Maintenance (Sources, Spare Parts Inventory, Special Tools, Etc.):
  - 15) Recommended spare parts list.
  - 16) Consumable materials list.
  - 17) Demonstrate other commonly occurring maintenance procedures not part of preventive maintenance program.
  - 18) Tour of Building to Identify:
    - a) Maintenance points and access locations.
    - b) Control equipment and locations
9. Deferred testing is conducted, as specified or required.
10. Except for deferred testing, functional testing is completed before Substantial Completion.

#### 1.4 RELATED WORK

- A. Additional commissioning requirements will be given in the following specification sections. All of the following sections apply to the Work of this section.
1. Plumbing Systems Commissioning.
  2. HVAC Systems Commissioning.
  3. Electrical Systems Commissioning.

#### 1.5 RESPONSIBILITIES

- A. All Parties:
1. Follow the Cx Plan.
  2. Attend commissioning scoping meeting and additional meetings, as necessary.
  3. Properly schedule, log, and discharge commissioning activities and responsibilities throughout this project.
- B. A/E:
1. Construction and Acceptance Phase:
    - a. Attend the commissioning scoping meeting and selected commissioning team meetings.
    - b. Perform normal submittal review, construction observation, as built drawing preparation, O&M manual review, etc., as contracted.
    - c. Provide latest documentation of design narrative documentation requested by the CxA.
    - d. Respond to RFIs generated through the commissioning process.
    - e. Review and approve the O&M manuals.
    - f. Assist in clarifying the operation and control of commissioned equipment in areas where the specifications, control drawings, or equipment documents are not sufficient for writing detailed testing procedures.
- C. Commissioning Authority (CxA): The primary role of the CxA is to develop and coordinate the execution of a testing plan, observe and document installation and performance - that systems are installed and functioning in accordance with the documented design intent and in accordance with the Contract Documents. The Contractors will provide all tools or the use of tools to start, check out and functionally test equipment and systems, except for specified testing with portable data loggers, which shall be supplied by the CxA. The CxA shall not assume responsibility for design concept, design criteria, compliance with codes, design or general construction scheduling, cost estimating, or construction management. The CxA may assist with problem solving and resolution of nonconformance and deficiencies, but ultimately that responsibility resides with the Owner and the A/E.
1. Construction and Acceptance Phase:
    - a. Develop Cx Plan.
    - b. 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 consultations with all necessary parties, frequently updated timelines and schedules, and technical expertise.
    - c. Provide commissioning activities information to the CM to coordinate the commissioning work and ensure that commissioning activities are scheduled into the master construction schedule prepared by the CM.
    - d. Plan and conduct a commissioning kick-off meeting and other commissioning meetings.
    - e. Revise, as necessary, the Cx Plan following the kick-off meeting.

- f. Request and review additional information required to perform commissioning tasks, including contractor start up and checkout procedures.
  - g. Before start up, gather and review the current control sequences and interlocks and work with contractors and design engineers until sufficient clarity has been obtained, in writing, to be able to write detailed testing procedures.
  - h. Write and distribute construction checklists as appropriate.
  - i. Perform site visits to observe component and system installations. Attend selected planning and job site meetings to obtain information on construction progress. Review construction meeting minutes for revisions/substitutions relating to the commissioning process. Assist in resolving any discrepancies.
  - j. Review all or part of the HVAC piping test and flushing procedures, sufficient to be confident that proper procedures were followed. Notify Owner's project manager of any deficiencies in results or procedures.
  - k. Witness all or part of any ductwork leakage testing procedures, sufficient to be confident that proper procedures were followed. Notify Owner's project manager of any deficiencies in results or procedures.
  - l. Approve completion of assigned construction checklists by reviewing construction checklist reports and by selected site observation and spot checking.
  - m. Approve systems start up by reviewing start up reports and by selected site observation.
  - n. Review Test, Adjust, and Balance execution plan.
  - o. Review the checkout plan for the controls portion of the HVAC instrumentation and controls.
  - p. Oversee sufficient controls system checkout and approve controls to be used for Test, Adjust, and Balance, before Test, Adjust, and Balance is executed.
  - q. Approve air systems balancing by reviewing completed reports. Perform spot checking or site observation as needed to approve balancing work.
  - r. With necessary assistance and review from installing contractors, write the functional test procedures for equipment and systems. This may include HVAC instrumentation and controls system trending, stand alone data logger monitoring or manual functional testing.
  - s. Analyze any functional performance trend logs and monitoring data to verify performance.
  - t. Coordinate, witness and approve manual functional tests performed by installing contractors. Coordinate retesting as necessary until satisfactory performance is achieved.
    - 1) The CxA shall have the authority to reschedule functional testing in part or in entirety at the time of scheduled testing if any of the following conditions exist: Required participants are not present, required pre test data is not complete, incomplete installation as required for testing, numerous test steps fail, indication of improper maintenance, inadequate instrumentation, existence of conditions unsafe to people or equipment.
  - u. Maintain an Issues Log and a separate testing record. Provide the CM with written reports with recommended actions.
  - v. Sign off (final approval) on individual commissioning tests as completed and passing. Recommend completion of the commissioning process to the Owner.
  - w. Confirm Owner training.
  - x. Compile and maintain a commissioning record.
  - y. Provide a final commissioning report (as described in this Section).
2. Warranty Period:
- a. Conduct seasonal and/or deferred functional testing.
  - b. Evaluate trend logs provided by the HI&C Sub. Make recommendations for system performance improvements based on trend log evaluations.
  - c. Ten to eleven months into the warranty period, conduct Near-Warranty-End Review meeting with Owner, CM, and Contractors to identify issues covered under warranty or under the original construction that are needing resolution, determine party responsible to resolve, and set timeline for resolution:
    - 1) Previous issues identified in commissioning still unresolved.
    - 2) New operation or performance issues observed.
- D. Construction Manager - Owner's Representative (CM):
- 1. Construction and Acceptance Phase:
    - a. Assign a single person to manage the commissioning activities on behalf of the CM and serve as a single point of contact and communication for the CM in all commissioning activities.

- b. Include commissioning activities in the master construction schedule and ensure MC, EC, TAB Sub, and HI&C Sub participation and responsiveness in the commissioning process. CM is responsible for dividing the Work among Subcontractors and Suppliers and for delineating the work to be performed by specific trades. The following are suggestions as to how the Work may be divided. This is not a complete list of all the work: Refer to the commissioning plan for more detailed information.
  - 1) Mechanical Subcontractor:
    - a) Provide related work as specified herein to support the mechanical systems Cx work being performed by CxA.
    - b) Perform system start up functions including, but not necessarily limited to: Operate all motorized equipment to confirm proper function.
    - c) Correct all mechanical system deficiencies identified by CxA.
  - 2) Testing, adjusting and balancing (TAB) engineer:
    - a) Provide timely notice to mechanical Subcontractor and CxA of all incomplete work and deficiencies which prevent proper performance of work.
    - b) Test, adjust, and balance all air and hydronic systems and prepare final report.
    - c) Correct all deficiencies in TAB work and TAB report as identified by CxA.
  - 3) HVAC Instrumentation and Controls (HI&C) subcontractor:
    - a) Provide related work as specified herein to support the mechanical systems Cx work being performed by CxA.
    - b) In a timely manner, review and comment on feasibility of functional test (FT) steps as developed by CxA.
    - c) Operate all temperature control devices to support Cx work:
      - (1) Operate each and every phase of the HI&C separately, or in conjunction one with the other for a sufficient period of time to demonstrate the ability of the system to meet performance requirements in accordance with the true intent and purpose of these Specifications.
      - (2) ECS Subcontractor is responsible for verifying and demonstrating that each Sequence of Operation is being performed and design conditions stably maintained under operating conditions through the use of FT procedures. HI&C Sub shall work with CxA in development of FT procedures.
    - d) Provide global command capability for all terminal control devices to aid in TAB and system performance testing, e.g.,
      - (1) VAV box damper position.
    - e) Correct all HI&C system deficiencies identified by CxA.
    - f) Provide CxA on line controls system access and training for CxA to view real time system operation and obtain historical trend data of controls points.
      - (1) Training and access shall be provided prior to functional testing.
      - (2) CxA access shall be maintained for the duration of the warranty period (typically one year following date of substantial completion)
- c. Enforce on time submittal of commissioning documentation by HI&C Sub, MC, EC, and TAB Sub, including systems manual documentation.
- d. Attend commissioning kick-off meeting and other commissioning team meetings to facilitate the commissioning process.
- e. Perform the normal review of Contractor submittals.
- f. Furnish a copy of all construction documents, addenda, change orders and approved submittals and shop drawings related to commissioned equipment to the CxA.
- g. When necessary, observe and witness construction checklist completion, start up and functional testing of selected equipment.
- h. Furnish CxA a copy of specification required construction test reports, e.g., pipe cleaning, pipe flushing, pipe and duct leak tests.
- i. Review commissioning progress and Issues Logs.
- j. Coordinate the resolution of deficiencies identified in all phases of commissioning.
- k. Coordinate and document completion of Owner training.
- l. Include the cost of commissioning in the total contract price.
- m. In each purchase order or subcontract written, include requirements for submittal data, O&M data, commissioning tasks and training.
- n. Prepare O&M manuals, according to the Contract Documents, including clarifying and updating the original sequences of operation to as built conditions.

2. Warranty Period:
  - a. Ensure that Subs execute seasonal or deferred function performance testing, witnessed by the CxA, according to the Specifications.
  - b. Ensure that the HI&C Sub provides system performance trend logs to CxA.
  - c. Ensure that Subs correct deficiencies and make necessary adjustments to O&M manuals and as built drawings for applicable issues identified in any seasonal testing.
- E. Participate in Near Warranty End meeting Owner:
  1. Construction and Acceptance Phase:
    - a. Arrange for facility operating and maintenance personnel to attend various field commissioning activities and training sessions.
    - b. Provide final approval for the completion of the commissioning work.
  2. Warranty Period:
    - a. Participate in Near Warranty End meeting.
- F. Equipment Suppliers:
  1. Provide all requested submittal data, including detailed start up procedures and specific responsibilities of the Owner to keep warranties in force.
  2. Assist in equipment testing as specified in agreements with Subs.
  3. Include all special tools and instruments (only available from vendor, specific to a piece of equipment) required for testing equipment according to these Contract Documents in the base bid price to the Contractor, except for stand-alone data logging equipment that may be used by the CxA.
  4. Through the contractors to whom they supply products, analyze specified products and verify that the designer has specified the newest most updated equipment.
  5. Provide information requested by CxA regarding equipment sequence of operation and testing procedures.
  6. Review test procedures for equipment installed by factory representatives.

## 1.6 SYSTEMS TO BE COMMISSIONED

- A. Refer to Individual Commissioning Specification Sections:
  1. Division 22 Section "Commissioning of Plumbing."
  2. Division 23 Section "Commissioning of HVAC."
  3. Division 26 Section "Commissioning of Electrical Systems."

## PART 2 - PRODUCTS

### 2.1 TEST EQUIPMENT

- A. All standard testing equipment required to perform start up and initial checkout and required functional testing shall be provided by the contractor for the equipment being tested.
- B. Special equipment, tools and instruments (only available from vendor, specific to a piece of equipment) required for testing equipment shall be included in the base bid price, and left on site, except for stand alone data logging equipment that may be used by the CxA.
- C. Portable data logging equipment and associated software required to test equipment will be provided by the CxA, but shall not become the property of the Owner.
- D. All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance within the tolerances specified in the Owner's project requirements document. If not otherwise noted, the following minimum requirements apply: Temperature sensors and digital thermometers shall have resolution of 0.1 degrees F and calibration within 6 months of use to an accuracy of  $\pm 0.5$  degrees F. Pressure sensors shall have been calibrated within 6 months of use to an accuracy of  $\pm 3.0\%$  of the value being measured (not full range of device)
  1. All calibration shall be to NIST traceable standards. (National Institute of Standards and Technology - [www.nist.gov](http://www.nist.gov), 301.975.6478).

2. All equipment shall be calibrated according to the manufacturer's recommended intervals and immediately after being dropped or damaged.
3. Calibration tags shall be affixed or certificates readily available.

PART 3 - EXECUTION

3.1 REFER TO ATTACHMENT A, COMMISSIONING PLAN

END OF SECTION 01 91 13



## SECTION 02 01 26 – MINOR ALTERATION WORK

### 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 minor alteration work and the major items listed below:
  - 1. Work on other floors in support of the renovation on the first floor.

#### 1.3 QUALITY ASSURANCE

- A. General:
  - 1. Test repair materials for compatibility with existing materials.
  - 2. Obtain Engineer's approval of test.
  - 3. Do not use incompatible materials.
- B. Fabrication and Installation Personnel Qualifications:
  - 1. Trained and experienced in the fabrication and installation of the materials and equipment.
  - 2. Knowledgeable of the design and the reviewed Shop Drawings.

### PART 2 - PRODUCTS

#### 2.1 MATERIALS FOR ALTERATIONS, PATCHING AND REPAIRS

- A. General:
  - 1. Provide new materials or acceptable salvaged materials.
  - 2. Acceptable salvaged material: As specified herein or as indicated on Drawings.
- B. Acceptable Salvaged Materials:
  - 1. Cleaned prior to reinstallation.
  - 2. In good condition without objectionable defects.
  - 3. Operate properly if an operable item.
- C. New Materials:
  - 1. Compatible with existing adjacent materials.
  - 2. Same types, sizes, qualities and colors as existing materials.
  - 3. Provide new materials when acceptable salvaged materials:
    - a. Are not available in sufficient quantity, or
    - b. Reuse is specifically not permitted.

### PART 3 - EXECUTION

#### 3.1 ALTERATIONS, PATCHING AND REPAIRS

- A. General: Not discernible from normal viewing distance.
- B. Restore Surfaces:
  - 1. Where damaged or defaced by:
    - a. Cutting.
    - b. Patching.
    - c. Demolition.
    - d. Alteration.
    - e. Repair work.

2. To a condition equal to that before the Work began.
3. With continuous and uniform finishes.

END OF SECTION 02 01 26

## SECTION 02 41 19 – 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. This Section includes the modification, alteration, conversion, and renovation of existing structures:
  - 1. Be aware of the many incidental items which exist which must be demolished, relocated, or replaced in order to accomplish the remodeling work of trades.
  - 2. Include the price of such demolition, relocating, and replacement in the base Bid.
  - 3. These incidental items may or may not be indicated in the Contract Documents.
  - 4. Contractor and Subcontractors performing remodeling work are expected to be familiar with the unknown nature of existing utilities serving an area to be remodeled and shall calculate the base Bid to include the demolition, removal, relocation, and replacement of these utilities.
- B. Portions of the building may be occupied during demolition. Every effort shall be made to minimize noise, dust, and vibration during normal business hours.

#### 1.3 REFERENCES

- A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with the pertinent provisions of the following:
  - 1. American National Standards Institute: ANSI A10.6 - Safety Requirements for Demolition Operations.
  - 2. ASTM: D1557 - Laboratory Compaction Characteristics of Soil Using Modified Effort.
  - 3. EPA: Rule 406(b) of the Toxic Substances Control Act of 1992.
  - 4. NFPA: NFPA 241 - Standard for Safeguarding Construction, Alteration, and Demolition Operations.

#### 1.4 DEFINITIONS

- A. Terms:
  - 1. Abandon:
    - a. Remove an item to the extent that it is not visible and does not interfere with new construction.
    - b. Portions of the abandoned item may be left in place as indicated on the Drawings.
    - c. No abandoned items shall be left below new footings.
  - 2. Demolish:
    - a. Remove existing items from their present location in the Project area and haul to an area outside of the Project area.
    - b. Remove utilities serving these items.
  - 3. Relocate:
    - a. Move existing items from their present location to another location in the Project area.
    - b. Extend utilities serving the present location to the new location.
  - 4. Remove:
    - a. Except for items indicated to be reused, salvaged, reinstalled, or otherwise indicated to remain Owner's property, demolished materials shall become Contractor's property.
    - b. Remove existing items from their present location in the Project area and haul to an area outside of the Project area.
    - c. Remove utilities serving these items.
  - 5. Replace:
    - a. Remove existing items from their present location in the Project area, haul them to an area outside of the Project area, and furnish and install new items in the same or another location.
    - b. Extend utilities serving the present location to the new location.
  - 6. Reuse: Move existing items from their present location to another location in the Project area. Extend utilities serving the present location to the new location.

7. Historic Items:
  - a. Historic items, relics, and similar object including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, antiques, and other items of interest or value to Owner that may be encountered during selective demolition remain Owner's property.
  - b. Carefully remove and salvage each item or object in a manner to prevent damage and deliver promptly to Owner.

#### 1.5 DIVISION OF WORK

- A. Work: In accordance with the General Conditions, Contractor is responsible for dividing the Work among the Subcontractors and Suppliers and for delineating the work to be performed by specific trades. The following are suggestions as to how the Work may be divided. This is not a complete list of the work:
  1. Contractor:
    - a. Cut and patch walls, floors, and ceilings to allow for recessed utilities and ductwork.
    - b. Remove and reinstall existing suspended ceilings to allow for above ceiling construction.
    - c. Replace damaged units.
    - d. Install new ceilings as indicated on the Drawings.
    - e. Place sleeves in new concrete structures.
    - f. Patch roof at new penetration and curbs and where existing penetrations and curbs are removed.
    - g. Furnish and install new structural steel where required for reinforcement at floor, wall, and roof openings.
    - h. Install fire stop and smoke stop systems at penetrations for ratings indicated in accordance with local building codes.
  2. Mechanical and Electrical:
    - a. Furnish sleeves for use in new concrete construction.
    - b. Install fire stop and smoke stop systems at utility penetrations in accordance with local building codes.
    - c. Furnish and install sleeves in gypsum board and masonry construction.
    - d. Core drill existing concrete for new utilities and sleeves after obtaining Engineer's review of locations.
  3. Miscellaneous:
    - a. Each trade shall be financially responsible for cutting and patching for sleeves, penetrations, and installation of isolated components as necessary for its work unless herein specifically stated to the contrary.
    - b. On renovation projects, cut and patch walls, floors, and ceilings to allow for continuous runs of recessed utilities and ductwork.
    - c. Patching shall be done by the trade whose work is damaged.
    - d. Costs caused by defective or ill-timed work shall be borne by the party responsible.
    - e. Each trade shall do fitting of its own work as required to make its several components fit together or to receive the work of other trades.

#### 1.6 SUBMITTALS

- A. Predemolition Audio-video:
  1. Submit showing existing conditions of construction to remain that could be misconstrued as damage caused by construction activities.
  2. Including building and Site, as well as interior and exterior finishes.
  3. Submit prior to commencing Work.

#### 1.7 QUALITY ASSURANCE

- A. Qualifications: Engage an experienced firm that has specialized in demolition work similar to material and extent indicated for this Project.
- B. Regulatory Requirements:
  1. Comply with governing EPA notification regulations before beginning selective demolition.
  2. Comply with hauling and disposal regulations of authorities having jurisdiction.
  3. Comply with ANSI A10.6 and NFPA 241.
  4. Comply with 29 CFR 1926.62-(OSHA Paint Standard).

- C. Pre-Demolition Conference:
  - 1. Conduct pre-demolition conference at Site in accordance with Division 01 Section "Project Meetings."
  - 2. Review methods and procedures related to selective demolition including, but not limited to, the following:
    - a. Inspect and discuss condition of construction to be selectively demolished.
    - b. Review structural load limitations of existing structure.
    - c. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and to avoid delays.
    - d. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.

## 1.8 PROJECT CONDITIONS

- A. Owner Occupancy:
  - 1. Owner will occupy portions of the Anibal building immediately adjacent to selective demolition area.
  - 2. Conduct selective demolition so Owner's operations will not be disrupted.
  - 3. Provide not less than 72 hours notice to Owner of activities that will affect Owner's operations.
- B. Access:
  - 1. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities.
  - 2. Do not close or obstruct walkways, corridors, or other occupied or used facilities without written permission from authorities having jurisdiction.
- C. Conditions:
  - 1. Owner and Engineer assume no responsibility for condition of areas to be selectively demolished.
  - 2. Conditions existing at time of inspection for bidding purposes will be maintained by Owner as far as practicable.
  - 3. Before selective demolition begins, Owner will remove the following items:
    - a. Office furnishings.
    - b. Lab equipment.
- D. Storage or sale of removed items or materials on Site will not be permitted.
- E. Maintenance of Utilities: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.
- F. Unknown Hazardous Materials:
  - 1. It is not expected that hazardous materials will be encountered in the Work.
  - 2. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Engineer and Owner in accordance with the General Conditions.
  - 3. Hazardous materials will be removed by Owner under a separate contract.
- G. Lead Paint: Remove and remediate existing lead paint as required to comply with all codes and requirements while performing the requirements of the Work. Either remove lead paint completely or partially as required to achieve this.

## 1.9 WARRANTIES

- A. Existing Warranties:
  - 1. 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.
  - 2. If possible, retain original installer or fabricator to patch exposed work that is damaged during selective demolition.
  - 3. If it is not possible to engage original installer or fabricator, engage another recognized, experienced, and specialized firm.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. General:
  - 1. Materials and workmanship shall conform to the requirements of other Sections of the Specifications.
  - 2. Where no materials are specified in these specifications, use materials of an equivalent type, quality, and size to match those existing in other areas of the facility.
  - 3. If none exist, use materials and workmanship recognized as of the highest quality in the industry.
  - 4. Obtain Engineer's review of such material and workmanship.
- B. Piping: Existing piping which is removed from its present location shall not be reused where new piping is required unless specifically noted on the Drawings.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify that utilities have been disconnected and capped.
- B. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.
- C. Inventory and record the condition of items to be removed and reinstalled, and of items to be removed and salvaged.
- D. Conflicts:
  - 1. 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.
  - 2. Promptly submit written report to Engineer.
- E. Survey, or engage a competent person to survey condition of the building, in accordance with requirements of OSHA, to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of the structure or adjacent structures during selective demolition operations.
- F. Perform additional surveys as the work progresses to detect hazards resulting from operations to date.

### 3.2 UTILITY SERVICES

- A. Maintain existing services indicated to remain and protect them against damage during selective demolition operations.
- B. Interruptions:
  - 1. Do not interrupt existing utilities serving occupied or operating facilities unless authorized in writing by Owner and other authorities having jurisdiction.
  - 2. Provide temporary services during interruptions to existing utilities, as acceptable to Owner and to authorities having jurisdiction.
  - 3. Provide at least 72 hours notice to Owner if shutdown of service is required during changeover.
- C. Utility Requirements:
  - 1. Locate, identify, disconnect, and seal or cap off indicated utilities serving areas to be selectively demolished.
  - 2. Owner will arrange to shut off indicated utilities when requested by Contractor.
  - 3. Arrange to shut off indicated utilities with utility companies.
  - 4. If utility services are required to be removed, relocated, or abandoned, before proceeding with selective demolition, provide temporary utilities that bypass areas of selective demolition and that maintain continuity of service to other parts of building.
  - 5. Cut off pipe or conduit in walls or partitions to be removed.
  - 6. Cap, valve, or plug and seal remaining portion of pipe or conduit after bypassing.

### 3.3 PREPARATION

#### A. Site Access and Temporary Controls:

1. Conduct selective demolition and debris removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
2. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and other authorities having jurisdiction.
3. Provide alternate routes around closed or obstructed traffic ways if required by governing regulations.
4. Erect temporary protection, such as walks, fences, railings, canopies, and covered passageways, where required by authorities having jurisdiction.
5. Protect existing Site improvements, appurtenances, and landscape features to remain.
6. Erect a plainly visible fence around drip line of individual trees or around perimeter drip line or groups of trees to remain.

#### B. Temporary Facilities:

1. Protection:
  - a. Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
  - b. Provide protection to ensure safe passage of people around selective demolition area, and to and from occupied portion of building.
  - c. Weather Protection:
    - 1) 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.
    - 2) Where heating or cooling is needed and permanent enclosure is not complete, provide insulated temporary enclosures.
    - 3) Coordinate enclosures with ventilating and material drying or curing requirements to avoid dangerous conditions and effects.
  - d. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
  - e. Cover and protect furniture, furnishings, and equipment that have not been removed.
2. Shoring and Bracing:
  - a. Provide and maintain shoring, bracing, or structural support to preserve stability and prevent movement, settlement, or collapse of construction to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.
  - b. Strengthen or add new supports when required during progress of selected demolition.

### 3.4 POLLUTION CONTROLS

#### A. Dust Control:

1. Use water mist, temporary closures, and other suitable methods to limit spread of dust and dirt.
2. Do not use water when it may damage existing construction or create hazardous or objectionable conditions, such as ice, flooding, and pollution.
3. Wet mop floors to eliminate trackable dirt and wipe down walls and doors of demolition enclosure.
4. Vacuum carpeted areas.
5. Comply with governing environmental protection regulations.

#### B. Disposal:

1. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
2. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.

### 3.5 GENERAL

#### A. Demolish and remove existing construction only to the extent required by new construction and as indicated.

#### B. Methods:

1. Use methods required to complete the work within limitations of governing regulations.
2. Level by Level:
  - a. Proceed with selective demolition systematically, from higher to lower level.

- b. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.
    3. Cutting Openings:
      - a. Neatly cut openings and holes plumb, square, and true to dimensions required.
      - b. Use cutting methods least likely to damage construction to remain or to adjoining construction.
      - c. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, to minimize disturbance of adjacent surfaces.
      - d. Temporarily cover openings to remain.
    4. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
    5. Flame Cutting:
      - a. Do not use cutting torches until work area is cleared of flammable materials.
      - b. At concealed spaces, such as duct and pipe chases, verify condition and contents of hidden space before starting flame-cutting operations.
      - c. Maintain portable fire suppression devices during flame-cutting operations.
      - d. Maintain adequate ventilation when using cutting torches.
    6. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials, and promptly and legally 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.
    10. Return elements of construction and surfaces that are to remain to condition existing before selective demolition operations began.
  - C. Existing Facilities: Comply with Owner's requirements for using and protecting elevators, stairs, walkways, loading docks, building entries, and other building facilities during the selective demolition operations.
  - D. Removed and Salvaged Items:
    1. Clean salvaged items.
    2. Pack or crate items after cleaning and identify contents of containers.
    3. Store items in a secure area until delivery to Owner.
    4. Transport items to Owner's storage area on Site designated by Owner.
    5. Protect items from damage during transport and storage.
  - E. Removed and Reinstalled Items:
    1. Clean and repair items to functional condition adequate for intended reuse.
    2. Paint equipment to match new equipment.
    3. Pack or crate items after cleaning and repairing and identify contents of containers.
    4. Protect items from damage during transport and storage.
    5. Reinstall items in locations indicated.
    6. Comply with requirements for new materials and equipment.
    7. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.
  - F. Existing Items to Remain:
    1. Protect construction indicated to remain against damage and soiling during selective demolition.
    2. When permitted by Engineer, items may be removed to a suitable, protected storage location and cleaned and reinstalled in their original locations after selective demolition operations are complete.

### 3.6 DEMOLITION

- A. Structures:
  1. Cut, repair, reuse, excavate, demolish or otherwise remove parts of the existing structures or appurtenances, as indicated on the Drawings, herein specified and necessary to permit completion of the Work.
  2. Dispose of demolished materials in an approved manner.
  3. Include necessary cutting, bending, and welding of reinforcing steel, structural steel, or miscellaneous metal work found embedded in the existing structures.



4. When removing materials or portions of existing structures, shore up, underpin, and protect adjacent structures.
  5. Concrete:
    - a. Demolish in small sections.
    - b. Cut concrete to a depth of at least 3/4-inch at junctures with construction to remain, using a power driven saw.
    - c. Dislodge concrete from reinforcement to remain at perimeter of areas being demolished, cut reinforcement, and then remove remainder of concrete indicated.
    - d. Neatly trim openings to dimensions indicated.
  6. Engineer's review of cutting: No existing structure, equipment or appurtenance shall be shifted, cut, removed or otherwise altered without obtaining review of Engineer.
- B. Equipment:
1. Dismantle, remove, and relocate existing equipment, piping, and other appurtenances required for the completion of the Work.
  2. Cut existing pipelines for the purpose of making connections thereto.
  3. Cut off anchor bolts for equipment and structural steel indicated to be removed 1-inch below the concrete surface.
  4. Patch remaining concrete surface to smooth even finish.
  5. Remove air conditioning equipment without releasing refrigerants, if applicable.
- C. Piping and Electrical Components:
1. When a new connection is made to an existing pipeline, install additional new piping, extending to and including the most convenient new valve.
  2. Piping, conduit, and wiring indicated or required to be demolished shall be done so to the nearest reasonable connection outside of the Project area or as directed by Engineer.
  3. Where necessary or required for the purpose of making connections, cut existing pipelines in a manner to provide an approved joint.
  4. Weld beads, flanges, and provide Dresser couplings on existing and new piping.
  5. Remove junction boxes and electrical outlets which will no longer be in use.
  6. At existing walls which are made thicker, extend piping and wiring to accommodate additional wall thickness.
  7. Remove and reinstall fixtures and electrical outlets, switches, etc.
- D. Ductwork:
1. Remove portions of existing ductwork systems to the nearest branch outside the project area, except as indicated otherwise on drawings.
  2. Remove existing ductwork in a manner to minimize dispersion of dust in the duct system.
  3. Repair and replace existing insulation and duct liner disturbed by this Work to provide a continuous smooth surface.
  4. New connections to existing ductwork shall comply with the requirements of Division 23 Section "Metal Ducts."
- E. Masonry Walls:
1. Where masonry walls are to be removed and replaced, and where filling existing openings, allow for tothing in of the new masonry at alternate courses so that the existing running bond pattern is maintained.
  2. Brick:
    - a. Existing brick which becomes exposed due to the removal of materials such as adjacent walls, windows, doors, cabinetry, equipment, etc., shall be thoroughly cleaned, scraped, brushed, and tuck pointed to match adjacent existing brick.
    - b. Blend appearance of exposed brick with the adjacent brick.
    - c. Replace damaged brick.
- F. Floor Slabs:
1. Where new utilities must be installed below the existing floor slab, saw cut the slab for at least 1-inch of depth.
  2. Break out the remaining depth with jack hammers or hand tools to provide a rough surface.
  3. Leave existing steel reinforcing so that it laps at least 6 inches into the new concrete slab over the trench.

4. The exact width of the concrete removed shall depend upon the required depth and diameter of the new utility.
  5. Allow for sufficient working space in the trench.
- G. Conceal Utilities: Recess new piping, conduit, and other utilities into floors, wires, and ceilings in finished areas.
- H. Ownership of Salvaged Materials:
1. Materials and equipment removed shall remain the property of Owner at Owner's option.
  2. Items not salvageable, as determined by Engineer and Owner, and items Owner elects not to keep shall become the property of Contractor to be properly disposed of off the Site.
  3. Salvaged equipment shall be thoroughly cleaned, lubricated, and greased for protection during prolonged storage.
- I. Nonshrink Grout: Use nonshrink grout for setting wall castings, sleeves, leveling pump bases, doweling anchors into existing concrete and elsewhere as indicated.
- J. Protect Facility from Water Damage: Provide flumes, hoses, piping, suitable plugs, bulkheads, or other means to divert or hold back the flow of wastewater, water, or other liquids, as required for proper performance of the Work.
- K. Blasting: Not permitted.
- L. Sleeves:
1. Subcontractors for mechanical, electrical, and other trades shall furnish sleeves and inserts for pipes, conduits, and similar items in forms, walls, partitions, and floors.
  2. Perform work in cooperation with Contractor.
  3. Place items in ample time so as not to delay operations.
  4. Do not place sleeves so they pass through beams, girders, and similar construction.
- M. Roofing: If existing roofing is to remain, obtain original roofing Manufacturer's approval and warranty on new roof penetrations and where removing existing roof penetrations and curbs.
- N. Firestopping and Smokestopping: Install firestop and smokestop systems at utility penetrations in accordance with local building codes and Division 07 Section "Firestopping."
- O. Miscellaneous: At existing walls which are made thicker, reinstall fire extinguisher cabinets, clocks, thermostats, and other wall hung items in new wall to accommodate additional wall thickness.
- 3.7 PATCHING AND REFINISHING
- A. Promptly repair damage to adjacent construction caused by selective demolition operations.
- B. Patching:
1. Patch and repair existing surfaces from which items have been removed leaving holes, fasteners, and surface blemishes exposed to view.
  2. Where repairs to existing surfaces are required, patch to produce surfaces suitable for new materials.
  3. Completely fill holes and depressions in existing masonry walls that are to remain with an approved masonry patching material applied according to Manufacturer's written recommendations.
  4. Comply with Division 01 Section "Cutting and Patching."
- C. Refinishing:
1. Prepare existing surfaces for finishes by scraping, sanding, filling, acid etching, and sand blasting to ensure bonding and a smooth finish.
  2. Refinish entire surfaces as necessary to provide an even finish.
  3. Refinish continuous surfaces to the nearest intersection and entirely finish assemblies.
  4. Restore exposed finishes of patched areas and extend restoration into adjoining construction in a manner that eliminates evidence of patching and refinishing.
  5. Refinish entire surfaces if necessary to remediate existing lead painted surfaces.

D. Floors and Walls:

1. Where floors or partitions that are demolished extend one finished area into another, patch and repair floor and wall surfaces in the new space.
2. Provide an even surface of uniform finish, color, texture, and appearance.
3. Remove existing floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.
4. Patch with durable seams that are as invisible as possible.
5. Provide materials and comply with installation requirements specified in other Sections of these Specifications.
6. Where patching occurs in a painted surface, apply primer and intermediate coats over the patch and apply final coat over entire unbroken surface containing patch.
7. Provide additional coats until patch blends with adjacent surfaces.
8. Where feasible, test and inspect patched areas after completion to demonstrate integrity of installation.

E. Ceilings: Patch, repair, or rehang existing materials as necessary to provide even plane surface of uniform appearance.

3.8 CLEANING

- A. Clean materials installed under this Section in accordance with Division 01 Section "Cleaning and Waste Management."
- B. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations.
- C. Return adjacent areas to conditions existing before selective demolition operations began.

END OF SECTION 02 41 19

## SECTION 03 30 03 – 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. This Section includes the furnishing and installation of formwork, reinforcement, and concrete.

#### 1.3 REFERENCES

- A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with the following:
  - 1. ACI - American Concrete Institute:
    - a. 211.1 - Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete.
    - b. 301 - Specifications for Structural Concrete.
    - c. 304R - Guide for Measuring, Mixing, Transporting and Placing Concrete.
    - d. 309R - Guide for Consolidation of Concrete.
    - e. 318 - Building Code Requirements for Structural Concrete.
    - f. 347R - Guide to Formwork for Concrete.
  - 2. ASTM Standard Specifications, Test Methods, and Classifications:
    - a. A185 – Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement.
    - b. A615 - Specification for Deformed and Plain Billet - Steel Bars for Concrete Reinforcement.
    - c. A1064 - Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
    - d. C31 – Practice for Making and Curing Concrete Test Specimens in the Field.
    - e. C33 - Specification for Concrete Aggregates.
    - f. C39 - Test Method for Compressive Strength of Cylindrical Concrete Specimens.
    - g. C94 - Specification for Ready-Mixed Concrete.
    - h. C138 – Test Method for Density (Unit Weight), Yield and Air Content (Gravimetric) of Concrete.
    - i. C143 – Test Method for Slump of Hydraulic-Cement Concrete.
    - j. C150 - Specification for Portland Cement.
    - k. C172 - Practice for Sampling Freshly Mixed Concrete.
    - l. C173 - Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
    - m. C231 - Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
    - n. C260 - Specification for Air-Entraining Admixtures for Concrete.
    - o. C309 - Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
    - p. C494 - Specification for Chemical Admixtures for Concrete.
    - q. C595 – Blended Hydraulic Cement.

#### 1.4 DESIGN AND PERFORMANCE REQUIREMENTS

- A. Formwork: Perform the design and engineering of formwork, as well as its construction.

#### 1.5 SUBMITTALS

- A. Shop Drawings: For reinforcing steel.
- B. Mix Designs: Submit for review prior to placing concrete.

#### 1.6 QUALITY ASSURANCE

- A. Special Inspections of Concrete: In accordance with Division 01 Section “Special Inspections and Tests.”

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. Formwork:
  - 1. Form grade plywood or metal panels; no torn edges or worn plywood.
  - 2. Form Release Agent: Non-staining, non-emulsifiable type.
  - 3. Form ties, spreaders, and accessories as required by the formwork design.
  - 4. Provide chamfered strips in exposed corners of concrete.
  
- B. Reinforcement:
  - 1. Reinforcing Bars:
    - a. ASTM A615.
    - b. Yield Stress:  $F_y = 60,000$  psi, Grade 60.
  - 2. Welded Wire Fabric:
    - a. ASTM A185 or A1064.
    - b. Yield Stress:  $F_y = 65,000$  psi.
  - 3. Accessories resting on surfaces to be left exposed as finished surfaces shall have plastic coated legs.
  
- C. Concrete Materials:
  - 1. Portland Cement: ASTM C150, Type I, or A595, Type 1L.
  - 2. Fly Ash: ASTM C618, Class C or F.
  - 3. Ground-Granulated Blast Furnace (GGBF) Slag: ASTM C989, Grade 100 or 120.
  - 4. Fine and Coarse Aggregates:
    - a. Inert, non-chemically reactive, and non-radioactive.
    - b. Conforming with ASTM C33.
  - 5. Water: Clean, fresh, and potable.
  - 6. Air-Entrainment:
    - a. ASTM C260.
    - b. For all concrete mixes except interior floor slabs and pads.
  - 7. Water Reducing Agents: ASTM C494.
  - 8. No calcium chloride allowed in materials used in concrete mix.
  - 9. Membrane Curing Compounds: ASTM C309.

### 2.2 CONCRETE MIXES

- A. Proportioning:
  - 1. Proportions of materials for concrete shall be in accordance with ACI 211.1.
  - 2. Mix Design 1:
    - a. Minimum Design Compressive Strength: 4,000 psi.
    - b. Maximum Coarse Aggregate Size: 3/8-inch.
    - c. Minimum Cementitious Content: 5 sacks.
    - d. Replacement of Cement by Fly Ash or Slag: Permitted, up to 35%.
    - e. Water-Cementitious Ratio: 0.52 maximum.
    - f. Slump Limits: 4 inches  $\pm$  1-inch before addition of water reducer, if any.
    - g. Entrained Air Content: 0%  $\pm$  1%.

### 2.3 SOURCE QUALITY CONTROL

- A. Production and Delivery:
  - 1. Batch, mix and transport ready mixed concrete in accordance with ASTM C94.
  - 2. Furnish ready-mix delivery tickets with each batch of concrete before unloading at the Site, on which is printed, stamped or written the following information:
    - a. Name of ready-mix batch plant.
    - b. Serial number of ticket.
    - c. Date and truck number.
    - d. Name of Contractor.
    - e. Project name and location.
    - f. Specific class of designation of concrete.
    - g. Amount of concrete (cubic yards).

- h. Time loaded or of first mixing of cement and aggregates.
    - i. Type, name and amount of admixture.
  3. Minor amounts of concrete may be mixed on Site with prior review by Engineer.

## 2.4 POST-INSTALLED ANCHORS

- A. Anchors that Resist Loads Through an Injectable Chemical Adhesive:
  1. In Concrete: Hilti HIT HY 200 Safe Set.
  2. In Solid Grouted Masonry: Hilti HIT-HY 270.
  3. In Hollow Brick or Hollow Masonry: Hilti HIT-HY 270 with screen tubes.
  4. Anchored Material: Carbon steel or stainless steel threaded rods or deformed reinforcing bars as specified herein or as indicated on the Drawings.
  5. Bonding Strength: Tested in accordance with ASTM E1512.
  6. If installation temperatures of base materials fall below 41 degrees F, review cold weather applications with Manufacturer.
- B. Screw Style Anchors Approved for Use in Solid Grouted Masonry:
  1. Hilti Kwik HUS EZ (ICC-ESR 3056).

## PART 3 - EXECUTION

### 3.1 ERECTION AND PLACEMENT

- A. Forms:
  1. Provide required forms, shores, bracing, breast timbers, form ties and accessories in sufficient quantities so as not to delay the work.
  2. Coordinate work with other trades for the installation of embedded items and form penetrations.
  3. Form Removal:
    - a. No earlier than 3 days for columns and walls.
    - b. No earlier than 7 days for beams and slabs.
- B. Reinforcement:
  1. Free from rust scale, loose mill scale, oil, paint, and other coatings which will destroy or reduce bond between steel and concrete at the time concrete is placed around it.
- C. Concrete:
  1. Handle concrete from mixer to place of final deposit in carts, buggies or conveyors.
  2. Compact concrete by mechanical vibration equipment, but do not transport concrete through forms by vibrating.
  3. Concrete Finish:
    - a. Formed Surfaces: As cast, smooth formed finish.
    - b. Unformed Exposed Surfaces:
      - 1) Interior: Smooth troweled finish unless specified otherwise.
      - 2) Exterior: Light broomed finish unless specified otherwise.
  4. As soon as possible after finishing or removing forms, treat surfaces with a liquid membrane-forming curing compound unless specified otherwise.
  5. Protect freshly placed concrete from damage due to extreme temperatures in accordance with ACI 305R and ACI 306R.
- D. Post-Installed Anchors:
  1. Install post-installed anchors:
    - a. In strict accordance with the installation instructions supplied by the Manufacturer.
    - b. In rotary hammer drilled holes, unless otherwise approved by Engineer.
    - c. In drilled out holes of the proper depth and diameter cleaned of dust and debris according to the Manufacturer's specific installation instructions.

2. Provide sizes, spacings, edge distances and embedment as indicated on the Drawings.
3. Anchors that Resist Loads Through an Injectable Chemical Adhesive:
  - a. Install in concrete with minimum age of 21 days, and in masonry with a minimum age of 7 days.
  - b. Do not apply load until adhesive has properly cured and developed specified strength where cure time shall be as called out in the Manufacturer's literature based on prevailing environmental conditions at the time of installation.

END OF SECTION 03 30 03

## SECTION 05 30 00 – METAL DECKING

### 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 the furnishing and installation of metal decking and accessories.

#### 1.3 REFERENCES

- A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with the following:
  - 1. American Society for Testing and Materials (ASTM) Standard Specifications:
    - a. A653 - Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process, Structural (Physical) Quality.
    - b. A924 - Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
    - c. A780 - Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
  - 2. American Institute Steel Construction (AISC) publications: Steel Construction Manual.
  - 3. American Iron and Steel Institute (AISI) publications:
    - a. Specification for the Design of Cold-Formed Steel Structural Members.
  - 4. Steel Deck Institute (SDI) publications:
    - a. Design Manual for Composite Decks, Form Decks and Roof Decks.
    - b. Diaphragm Design Manual.
    - c. Roof Deck Specification.

#### 1.4 SUBMITTALS

- A. Shop Drawings: For metal decking to include:
  - 1. Sizes, profiles and lengths.
  - 2. Locations.
  - 3. Details of erection.
  - 4. Type of finish.
- B. Certification: Furnish a mill certification or laboratory test data verifying that yield strength and metal thicknesses comply with these Specifications, if requested by Engineer.

#### 1.5 DELIVERY, STORAGE AND HANDLING

- A. Protect decking with coverings while in transit and while stored at Site.
  - 1. Allow adequate air movement beneath coverings.
  - 2. Provide blocking under stored decking to:
    - a. Provide sloped drainage.
    - b. Keep decking off ground.

### PART 2 - PRODUCTS

#### 2.1 MATERIALS

- A. General:
  - 1. Materials shall comply with one or more of the following:
    - a. Galvanized Deck:
      - 1) ASTM A653, Grade SS.
      - 2) ASTM A924, G60.



- B. Composite Floor Deck:
  - 1. Noncellular steel form deck and accessories.
  - 2. Type and Size: As indicated on the Drawings.
  - 3. Minimum Yield Strength of Steel Sheet: 40,000 psi.
  - 4. Minimum Section Modulus: 0.224 cu.in. for S+ and 0.229 cu.in. for S-.
  - 5. Galvanized.

## 2.2 FABRICATION

- A. Fabricate to obtain continuity over as many spans as practicable.

## PART 3 - EXECUTION

### 3.1 ERECTION

- A. General
  - 1. Erect decking and weld to supports in accordance with Manufacturer's specifications, as herein specified and as indicated on the Drawings.
  - 2. Install decking in conformance with UL design numbers as indicated on the Drawings.
  - 3. Field cutting of openings through the deck shall be less than 16 square feet in area. Perform skew cutting in the field.
  - 4. Touch up field welds on the top surface of deck and damaged areas with paint similar to specified deck finish.
  - 5. Touch up damaged galvanized areas with a zinc rich paint meeting ASTM D520 and ASTM A780.
- B. Composite Floor Deck:
  - 1. Anchorage:
    - a. Anchor floor deck to supporting members as indicated on the Drawings.
  - 2. Side Laps:
    - a. Fasten with screws as indicated on the Drawings.
    - b. Fastener Spacing: As indicated on the Drawings.
  - 3. Closures: Furnish end enclosures, side closures and column closures as required to seal the deck for concrete pour.

### 3.2 CLEANING

- A. Prior to acceptance of the work of this Section, thoroughly clean deck and affected areas in accordance with Division 01 Section "Cleaning and Waste Management."

END OF SECTION 05 30 00

## SECTION 05 50 00 – METAL FABRICATIONS

### 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 furnishing, fabrication, and erection of metal fabrications, including the major items listed below:
  1. Loose angle and wide flange lintels.
  2. Steel stairs and landings including posts, bearing plates and integral support beams.
  3. Bollards.
  4. Bearing plates for other items specified herein.
  5. Channel or bent plate door frames.
  6. Galvanizing of selected items.
  7. Base plates, setting plates and anchor bolts for columns.
  8. Columns.
  9. Beams.

#### 1.3 REFERENCES

- A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with the pertinent provisions of the following:
  1. ASTM Standard Specifications:
    - a. A36 - Structural Steel.
    - b. A307 - Carbon Steel Bolts and Studs, 60,000 psi, Tensile Strength.
    - c. A325 - Structural Bolts, Heat-Treated, 120/105 ksi Minimum Tensile Strength.
    - d. A992 - Steel for Structural Shapes for Use in Building Framing.
    - e. E488 - Strength of Anchors in Concrete and Masonry Elements.
    - f. E1512 - Testing Bond Performance of Adhesive-Bonded Anchors.
    - g. F1554 - Anchor Bolts, Steel, 36, 55, and 105 ksi Yield Strength.
  2. AISC publications:
    - a. Code of Standard Practice for Steel Buildings and Bridges (excluding Section 4.2.1).
    - b. Specification for the Design, Fabrication and Erection of Structural Steel for Buildings.
    - c. Detailing for Steel Construction.
    - d. Manual of Steel Construction.
    - e. Specification for Structural Joints Using ASTM A325 or A490 Bolts.
  3. AWS publications: ANSI/AWS D1.1 - Structural Welding Code - Steel.
  4. ASME - American Society of Mechanical Engineers:
    - a. ANSI/ASME B18.2.1 - Heavy Hex Structural and Askew Head Bolts.
    - b. ANSI/ASME B18.22.1 - Plain Washers.
  5. Federal Specifications: FS FF-B-588C(1) - Bolt, Toggle, and Expansion Sleeve, Screw.
  6. American Hot-Dip Galvanizers Association.
  7. Occupational Safety and Health Act.
  8. NAAMM - National Association of Architectural Metal Manufacturers.

#### 1.4 CONNECTION DESIGN REQUIREMENTS

- A. Fabricator:
  1. Responsible for the structural design of all connections except those specifically indicated on the Drawings as Engineer designed.
  2. Responsible for the design of moment connections where indicated on the Drawings.
  3. Coordinate type of connection (bolted or welded) with steel erector.
- B. General Types of Connections: Indicated on Drawings.

## 1.5 SUBMITTALS

- A. Shop Drawings: For all members to be furnished to include:
  - 1. Detail Drawings of Members and Connections:
    - a. In accordance with AISC - Detailing for Steel Construction.
    - b. Size and number of bolts.
    - c. Dimensions.
    - d. Connection angles and plates.
  - 2. Erection Drawings: Locate and identify members.
  - 3. Welding: In accordance with AWS welding symbols.
  - 4. Type of paint.
  - 5. Item to be galvanized.
- B. Mill Certification Tests: Submit in compliance with International and Michigan Building Codes.
- C. Provide setting drawings, templates, and directions for the installation of anchor bolts and other devices.

## 1.6 QUALITY ASSURANCE

- A. Fabrication and Erection Personnel Qualifications:
  - 1. Trained and experienced in the type of work being performed.
  - 2. Knowledgeable of the design and the reviewed Shop Drawings.
- B. Welders, Welding Operators and Tackers Qualifications:
  - 1. Qualified by tests in accordance with AWS D1.1.
  - 2. Qualification Papers:
    - a. Given by an independent testing laboratory.
    - b. Dated no earlier than 6 months prior to beginning of Project.
  - 3. Engineer, at Engineer's discretion, may accept evidence of previous qualifications.
- C. Steel Fabricators:
  - 1. Certified under the AISC Quality Certification Program for Category I - Conventional Steel Structures, or under other quality control program acceptable to building official in accordance with building code, prior to fabrication.
  - 2. The quality control program shall permit work on fabricator's premises without special inspection.
- D. Special Inspection of Steel Erection: In accordance with Division 01 Section "Special Inspections and Tests."

## 1.7 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials in original, unbroken, brand marked containers or wrapping as applicable.
- B. Handle and store materials in a manner which will prevent deterioration, damage, contamination with foreign matter, damage by weather or elements, and in accordance with Manufacturer's directions.
- C. Reject damaged, deteriorated or distorted material and immediately remove from the Site. Replace rejected materials with new material at no additional cost to Owner.
- D. Embedded Items:
  - 1. Includes anchor rods and other anchorage devices which are to be embedded in cast-in-place concrete or masonry.
  - 2. Delivered on the Project Site in time to be installed before the start of cast-in-place concrete or masonry operations.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. General: Materials shall be new, top quality of their respective kinds, standard sizes and fabricated in a shop whose principal business is manufacturing the items specified in this Section.
- B. Steel:
  - 1. Wide Flange and WT Shapes: ASTM A992 with yield stress of 50,000 psi.
  - 2. M, S, MT and ST Shapes, Channels, Angles, Bars, Plates and Rods: ASTM A36 with yield stress of 36,000 psi.
  - 3. Rectangular and Square Tubular Shapes: ASTM A500, Grade C with yield stress of 50,000 psi.
- C. Paint: In accordance with Division 09 Section "Interior Painting."

### 2.2 POST-INSTALLED ANCHORS

- A. Anchors that Resist Loads Through an Injectable Chemical Adhesive:
  - 1. In Concrete: Hilti HIT HY 200 Safe Set.
  - 2. Anchored Material: Carbon steel or stainless steel threaded rods or deformed reinforcing bars as specified herein or as indicated on the Drawings.
  - 3. Bonding Strength: Tested in accordance with ASTM E1512.
  - 4. If installation temperatures of base materials fall below 41 degrees F, review cold weather applications with Manufacturer.

### 2.3 METAL FABRICATIONS

- A. Steel Stairways:
  - 1. Design:
    - a. Design shall be performed by the Supplier.
    - b. Minimum Design Live Load: 125 pounds per square foot.
    - c. Referenced standards of NAAMM and AISC shall be followed.
  - 2. Concrete filled metal pan stair and landings. Concrete filled metal pan stairs shall have a 1-inch minimum overhanging riser.
  - 3. 12 gage sheet steel, minimum, for pans and landing in accordance with ASTM A366.
  - 4. Minimum Stringer Size: MC12 x 10.6.
  - 5. Support steel and connections as required.
- B. Fasteners:
  - 1. Bolts:
    - a. Use carbon or alloy steel, ASTM A325 3/4-inch diameter bolts or larger as required by connection design.
    - b. Use ASTM A490 3/4-inch diameter bolts or larger only if required by connection design.
    - c. If conditions require that galvanized materials be used, use ASTM A307 or A325 bolts. Do not galvanize A490 bolts, as that could possibly cause hydrogen embrittlement, and will affect hardness.
    - d. Stainless steel: ASTM F593, used where conditions of severe corrosion could occur.
  - 2. Nuts:
    - a. Carbon Steel: ASTM A563.
    - b. Stainless Steel: ASTM F594.
  - 3. Washers:
    - a. Hardened Steel Washers: ASTM F436.
    - b. Plain Washers: ASME B18.22.1, round, carbon steel.
    - c. Lock Washers: ASME B18.21.1, helical, spring type, carbon steel.
- C. Anchor Rods: ASTM F1554, Grade 36.

- D. Other Materials: Other materials not specifically described but required for a complete and proper installation of the work of this Section, shall be new, first quality of their respective kinds, and as selected by Contractor subject to approval of Engineer.

## 2.4 FABRICATION

### A. General:

1. Workmanship: Install items square and level, accurately fitted and free from distortion and defects.
2. Temporary Bracing:
  - a. Make provision for erection stresses by temporary bracing.
  - b. Keep work in alignment.
3. Welding:
  - a. Steel welding shall be performed in accordance with AISC Specification and AWS D1.1.
  - b. Filler metal requirements for steel welding processes shall be in accordance with AWS D1.1 and AWS A5.1.
  - c. Aluminum welding shall be performed in accordance with AWS D1.2.
  - d. Filler metal requirements for aluminum welding processes shall be in accordance with AWS A5.3.
  - e. Stainless steel welding shall be performed in accordance with AWS D1.6.
  - f. Filler metal requirements for stainless steel welding processes shall be in accordance with AWS A5.4.
  - g. Welding shall be continuous along entire area of contact.
4. Painting: Prime paint metal fabrications in accordance with Division 09 Section "Interior Painting."
5. Items fabricated from structural steel members which are to be architecturally exposed shall be given special attention for material selection with respect to rolling tolerances, surface finish and straightness.
6. Normal structural steel fabrication tolerances will not be acceptable where in conflict with the intent and requirements of this Section.
7. Curved beam sections shall be fabricated without distortion to top and bottom flange width and thickness.
8. Straightness tolerances, additive to deflection, shall not exceed  $\pm 1/16$ -inch to 10 feet.
9. Cope, miter, and butt caps on exposed surfaces shall be made to the closest possible tolerances consistent with metal shop equipment and practice in order to provide a pleasing appearance.
10. Fastening shall be concealed where practicable. Thickness or metal and details of assembly and supports shall give ample strength and stiffness. Joints exposed to weather shall be formed to exclude water. Provide holes and connections for the work of other trades.

### B. Galvanizing:

1. Hot-dipped galvanized after fabrication in accordance with ASTM A123.
2. 2 oz/ sq ft minimum.
3. Galvanize the following items:
  - a. Bolts, nuts, and washers for connections within enclosed but unconditioned spaces, including canopies and above colonnades.
  - b. Items so indicated on the Drawings.
  - c. Bollards.

### C. Galvanized Fasteners:

1. Hot-dipped galvanized after fabrication in accordance with ASTM A153.
2. Class C (1.25 oz/sq ft) minimum coating.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Workmanship: Install items square and level, accurately fitted and free from distortion and defects.

### B. Erection:

1. Bracing:
  - a. Provide all shoring, bracing and accessories required for complete erection.
  - b. Safety and adequacy of bracing and temporary bracing are the responsibility of the Contractor.

- C. Coordination: Supply to appropriate trades items to be cast into concrete or embedded in masonry, complete with necessary setting templates.
- D. Tightening:
  - 1. Tighten bolts snug-tight as defined by AISC, unless otherwise noted on the Drawings.
  - 2. Tighten bolts in slotted holes using the AISC Turn-of-the-Nut Method, unless indicated otherwise on the Drawings.
  - 3. Where specifically indicated on the Drawings, finger-tighten nuts in connections where movement must be permitted, and tighten a jam nut over finger-tightened nut, or peen bolt threads, to prevent nut backoff.
- E. Touch-up:
  - 1. After erection is complete, touch up all shop priming coats damaged during transportation and erection.
  - 2. Prime all field welds, bolt heads, nuts and abrasions using the priming paint specified for shop priming.
  - 3. Touch up all damaged galvanized areas with a zinc rich paint meeting ASTM D520 and ASTM A780.
- F. Welding: Field welding shall be performed to the same standards and requirements of shop welding.
- G. Protection: Where required, provide approved protection against galvanic action between contacts of dissimilar metal or situations that will cause deterioration of metal in contact or associated in any way.

### 3.2 CLEANING

- A. Prior to acceptance of the work of this Section, thoroughly clean all installed materials and related areas in accordance with Division 01 Section "Cleaning and Waste Management."

END OF SECTION 05 50 00

## SECTION 05 73 00 - DECORATIVE METAL RAILINGS

### PART 1 GENERAL

#### 1.1 SECTION INCLUDES

- A. Railing systems.

#### 1.2 SUBMITTALS

- A. Shop Drawings: Indicate railing system elevations and sections, details of profile, dimensions, sizes, connection attachments, anchorage, size and type of fasteners, and accessories. Indicate anchor and joint locations, brazed connections, transitions, and terminations.
- B. Manufacturer's Instructions: Indicate installation.

#### 1.3 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in factory-provided protective coverings and packaging.
- B. Protect materials against damage during transit, delivery, storage, and installation at site.
- C. Inspect materials upon delivery for damage. Replace damaged items.
- D. Prior to installation, store materials and components under cover in dry location.

### PART 2 PRODUCTS

#### 2.1 RAILING SYSTEMS

- A. General: Factory- or shop-fabricated to suit project conditions, for proper connection to building structure, and in largest sizes practical for delivery to site.
- B. Performance Requirements: Applying loads simultaneously not required; design and fabricate railings and anchorages to resist loads without failure, damage, or permanent set, including:
  - 1. Lateral Force: 75 lb minimum, when tested in accordance with ASTM E935.
  - 2. Distributed Load: 50 lbf/ft minimum, applied vertically and horizontally at top of handrail, when tested in accordance with ASTM E935.
  - 3. Concentrated Loads: 200 lb minimum, applied to handrail horizontally and vertically, in accordance with ASTM E935.
  - 4. Handrails: Comply with ADA Standards.
- C. Assembly: Use slip-on, nonweld mechanical fittings, flanges, escutcheons, and wall brackets to join lengths, seal open ends, and conceal exposed mounting bolts and nuts.
- D. Joints: Machined smooth with hairline seams; tightly fitted and secured.
- E. Field Connections: Provide sleeves to accommodate site assembly and installation.
- F. Wall-Mounted Handrail:
  - 1. 1-1/4-inch IPS / 1.66-inch OD aluminum, color anodized finish.

- a. Color: Black
2. Handrail Brackets: Manufacturer's standard aluminum brackets.
  - a. Mounting: Wall.
  - b. Finish: Color anodized.
    - 1) Color: Black

## 2.2 MATERIALS

- A. Aluminum Components: ASTM B221 or ASTM B221M.
  1. Tubes: Schedule 40 pipe.
  2. Extruded Aluminum: ASTM B221 or ASTM B221M, 6063 alloy, T6 temper.

## 2.3 FINISHES

- A. General: Comply with NAAMM AMP 500-06.
  1. Complete mechanical finishes before fabrication. After fabrication, finish joints, bends, abrasions, and surface blemishes to match sheet.
  2. Protect mechanical finishes on exposed surfaces from damage.
  3. Apply organic and anodic finishes to formed metal after fabrication.
  4. Appearance: Limit variations in appearance of adjacent pieces to one-half of range represented in approved samples. Noticeable variations in same piece are not acceptable. Install components within range of approved samples to minimize contrast.
- B. Aluminum Finishes:
  1. Class I Color Anodized Finish: AAMA 611 AA-M12C22A44, electrolytically deposited, colored anodic coating not less than 0.7 mil, 0.007 inch thick.
  2. Color: Black.

## 2.4 ACCESSORIES

- A. Nonweld Mechanical Fittings for Aluminum Railings: In-line aluminum fittings, with flush setscrews for tightening by standard hex wrench, no bolts or screw fasteners.
- B. Anchors and Fasteners: Provide anchors, fasteners, and other attachment devices required to attach to structure. Ensure attachment devices are of same material as components unless indicated otherwise.
- C. Sealant: Silicone; black.
- D. Finish Touch-Up Materials: As recommended by manufacturer for field application.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Verify that substrate and site conditions are acceptable and ready to receive work.
- B. Verify field dimensions of locations and areas to receive work.
- C. Notify Architect immediately of conditions that would prevent satisfactory installation.
- D. Do not proceed with work until detrimental conditions are corrected.



### 3.2 PREPARATION

- A. Protection of In-Place Conditions: Protect existing work before proceeding with installation.
- B. Review installation drawings before beginning installation. Coordinate diagrams, templates, instructions, and directions for installation of anchorages and fasteners.
- C. Clean surfaces to receive railings. Remove materials and substances detrimental to installation.

### 3.3 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install components plumb and level, accurately fitted, free from distortion or defects, and with tight joints, except where necessary for expansion.
- C. Anchor securely to structure.
- D. Conceal anchor bolts and screws whenever possible. Where not concealed, use flush countersunk fastenings.
- E. Isolate dissimilar materials with bituminous coating, bushings, grommets, or washers to prevent electrolytic corrosion.

### 3.4 TOLERANCES

- A. Maximum Variation From Plumb: 1/4 inch per floor level, noncumulative.
- B. Maximum Offset From True Alignment: 1/4 inch.
- C. Maximum Out-of-Position: 1/4 inch.

### 3.5 CLEANING

- A. Remove protective film from exposed metal surfaces.
- B. Metal: Clean exposed metal finishes with potable water and mild detergent in accordance with manufacturer recommendations; do not use abrasive materials or chemicals, detergents, or other substances that may damage material or finish.

### 3.6 PROTECTION

- A. Protect installed components and finishes from damage after installation.
- B. Repair damage to exposed, making finishes indistinguishable from undamaged areas.
- C. Replace finishes and components that have irreparable damage. Ensure damaged areas are indistinguishable from undamaged finishes and surfaces.

END OF SECTION

## SECTION 06 41 00 - ARCHITECTURAL WOOD CASEWORK

### PART 1 GENERAL

#### 1.1 SECTION INCLUDES

- A. Specially fabricated cabinet units.
- B. Hardware.
- C. Factory finishing.
- D. Preparation for installing utilities.

#### 1.2 SUBMITTALS

- A. Shop Drawings: Indicate materials, component profiles, fastening methods, jointing details, and accessories.
  - 1. Scale of Drawings: 1-1/2 inch to 1 foot, minimum.
  - 2. Provide information as required by AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS).
- B. Product Data: Provide data for hardware accessories.
- C. Samples: Submit actual samples of architectural cabinet construction, minimum 12 inches square, illustrating proposed cabinet, countertop, and shelf unit substrate and finish.

#### 1.3 QUALITY ASSURANCE

- A. Fabricator Qualifications: Company specializing in fabricating the products specified in this section with minimum five years of documented experience.

#### 1.4 DELIVERY, STORAGE, AND HANDLING

- A. Protect units from moisture damage.

#### 1.5 FIELD CONDITIONS

- A. During and after installation of custom cabinets, maintain temperature and humidity conditions in building spaces at same levels planned for occupancy.

### PART 2 PRODUCTS

#### 2.1 CABINETS

- A. Quality Standard: Custom Grade, in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), unless noted otherwise.
- B. Plastic Laminate Faced Cabinets: Custom grade.
- C. Cabinets:
  - 1. Finish - Exposed Exterior Surfaces: Decorative laminate.

2. Finish - Exposed Interior Surfaces: Decorative laminate.
3. Finish - Semi-Exposed Surfaces: Decorative laminate
4. Finish - Concealed Surfaces: Manufacturer's option.
5. Door and Drawer Front Edge Profiles: Square edge with thin applied band.
6. Door and Drawer Front Retention Profiles: Fixed panel.
7. Casework Construction Type: Type A - Frameless.
8. Interface Style for Cabinet and Door: Style 2 - Finish Inset; reveal overlay.
9. Adjustable Shelf Loading: 40 psf.
  - a. Deflection: L/144.
10. Cabinet Style: Flush overlay.
11. Cabinet Doors and Drawer Fronts: Flush style.
12. Drawer Side Construction: Multiple-dovetailed.
13. Drawer Construction Technique: Dovetail joints.

## 2.2 WOOD-BASED COMPONENTS

- A. Wood fabricated from old growth timber is not permitted.

## 2.3 LAMINATE MATERIALS

- A. Manufacturers:
  1. As indicated on Drawings.

## 2.4 ACCESSORIES

- A. Adhesive: Type recommended by fabricator to suit application.
- B. Plastic Edge Banding: Extruded PVC, convex shaped; smooth finish; self locking serrated tongue; of width to match component thickness.
  1. Color: Match to HDPL on face on cabinets, as indicated on Drawings.
  2. Use at all exposed plywood edges.
  3. Use at all exposed shelf edges.
- C. Bolts, Nuts, Washers, Lags, Pins, and Screws: Of size and type to suit application; galvanized or chrome-plated finish in concealed locations and stainless steel or chrome-plated finish in exposed locations.
- D. Concealed Joint Fasteners: Threaded steel.

## 2.5 HARDWARE

- A. Hardware: BHMA A156.9, types as recommended by fabricator for quality grade specified.
- B. Metal Z-Shaped Wall Cabinet Support Clips: Paired, cleated, structural anchorage components applied to back of cabinets and walls for wall cabinet mounting.
  1. Material: Extruded Aluminum.
- C. Adjustable Shelf Supports: Standard side-mounted system using recessed metal shelf standards or multiple holes for pin supports and coordinated self rests, polished chrome finish, for nominal 1 inch spacing adjustments.
- D. Adjustable Shelf Supports: Standard back-mounted system using surface mounted metal shelf standards and coordinated cantilevered shelf brackets, satin chrome finish, for nominal 1 inch spacing adjustments.
- E. Countertop Support Brackets: Fixed, L-shaped, face-of-stud mounting.

1. Materials: Aluminum sections.
    - a. Finish: Black powder coat.
    - b. Height: 18 inches.
    - c. Support Length: 18 inches.
  2. Products:
    - a. Rakks/Rangine Corporation; Concealed EH Series Brackets: [www.rakks.com/#sle](http://www.rakks.com/#sle).
- F. Vanity Brackets: Fixed, ADA-compliant, face-of-stud mounting.
- G. Drawer and Door Pulls: "U" shaped wire pull, steel with chrome finish, 4 inch centers.
- H. Cabinet Catches and Latches:
  1. Type: Friction catch.
  2. Manufacturers:
    - a. Rockler Companies, Inc: [www.rockler.com/#sle](http://www.rockler.com/#sle).
- I. Drawer Slides:
  1. Type: Full extension.
  2. Static Load Capacity: Commercial grade.
  3. Mounting: Side mounted.
  4. Stops: Integral type.
  5. Features: Provide self closing/stay closed type.
- J. Hinges: European style concealed self-closing type, steel with nickel-plated finish.
- K. Soft Close Adapter: Concealed, frame-mounted, screw-adjustable damper; steel with polished finish.
- L. Mechanical Automatic Opening System: Concealed; steel with polished finish.

## 2.6 FABRICATION

- A. Assembly: Shop assemble cabinets for delivery to site in units easily handled and to permit passage through building openings.
- B. Edging: Fit shelves, doors, and exposed edges with specified edging. Do not use more than one piece for any single length.
- C. Fitting: When necessary to cut and fit on site, provide materials with ample allowance for cutting. Provide matching trim for scribing and site cutting.
- D. Plastic Laminate: Apply plastic laminate finish in full uninterrupted sheets consistent with manufactured sizes. Fit corners and joints hairline; secure with concealed fasteners. Slightly bevel arises. Locate counter butt joints minimum 2 feet from sink cut-outs.
  1. Apply laminate backing sheet to reverse side of plastic laminate finished surfaces.
  2. Cap exposed plastic laminate finish edges with material of same finish and pattern.
- E. Provide cutouts for plumbing fixtures. Verify locations of cutouts from on-site dimensions. Prime paint cut edges.

## 2.7 SHOP FINISHING

- A. Sand work smooth and set exposed nails and screws.

- B. For opaque finishes, apply wood filler in exposed nail and screw indentations and sand smooth.
- C. On items to receive transparent finishes, use wood filler matching or blending with surrounding surfaces and of types recommended for applied finishes.
- D. Finish work in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), Section 5 - Finishing for grade specified and as follows:

### PART 3 EXECUTION

#### 3.1 EXAMINATION

- A. Verify adequacy of backing and support framing.
- B. Verify location and sizes of utility rough-in associated with work of this section.

#### 3.2 INSTALLATION

- A. Install work in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS) requirements for grade indicated.
- B. Set and secure custom cabinets in place, assuring that they are rigid, plumb, and level.
- C. Use fixture attachments in concealed locations for wall mounted components.
- D. Use concealed joint fasteners to align and secure adjoining cabinet units.
- E. Secure cabinets to floor using appropriate angles and anchorages.

#### 3.3 ADJUSTING

- A. Adjust moving or operating parts to function smoothly and correctly.

#### 3.4 CLEANING

- A. Clean casework, counters, shelves, hardware, fittings, and fixtures.

END OF SECTION

## SECTION 06 42 00 - WOOD PANELING

### PART 1 GENERAL

#### 1.1 SECTION INCLUDES

- A. Wood wall paneling.
- B. Reclaimed wood paneling.

#### 1.2 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data on fire-retardant treatment materials and application instructions.
- C. Shop Drawings: Indicate materials, component profiles, fastening methods, jointing details, and accessories.
  - 1. Scale of Drawings: 1-1/2 inch to 1 foot, minimum.
- D. Samples: Submit two samples, 6x6 inch in size.

#### 1.3 QUALITY ASSURANCE

- A. Quality Certification: Unless otherwise indicated, comply with AWI "Quality Standards" for grades of paneling indicated for construction, finishes, installation, and other requirements.

#### 1.4 MOCK-UP

- A. Construct mock-ups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
- B. Mock-ups may be constructed off-site if environmental requirements do not meet Project Conditions article below.
- C. Approved mock-ups may become part of the completed Work if undisturbed at time of Substantial Completion.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect work from moisture damage.
- B. Do not deliver wood materials to project site until building is fully enclosed and interior temperature and humidity are in accordance with recommendations of AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS). If paneling must be stored in other than installation areas, store only in areas where environments comply with requirements specified in "Project Conditions" Article.

## 1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install paneling until building is enclosed, wet work is complete, and HVAC system is operating and will maintain temperature and relative humidity at occupancy levels during the remainder of the construction period.
- B. Field Measurements: Where paneling is indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
  - 1. Locate concealed framing, blocking, and reinforcements that support paneling by field measurements before being enclosed and indicate measurements on Shop Drawings.

## 1.7 COORDINATION

- A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to ensure that paneling can be installed as indicated.

## PART 2 PRODUCTS

### 2.1 PANELING

- A. Quality Standard: Custom Grade, in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), unless otherwise indicated.
  - 1. Minimum Class C flame spread index.
- B. Wood Paneling:
  - 1. Thickness variation: 0.43" and 0.51".
  - 2. Width: 14"
  - 3. Length: 47"
  - 4. Species: White Oak
  - 5. Finish: 100% Natural Oil
  - 6. Manufacturers: As indicated on Drawings. Substitutions not permitted.

### 2.2 INSTALLATION MATERIALS

- A. Furring, Blocking, Shims, and Hanging Strips: Softwood or hardwood lumber, kiln dried to less than 15 percent moisture content.

### 2.3 FABRICATION

- A. Prepare panels for delivery to site, permitting passage through building openings.
- B. Finish exposed edges of panels as specified by grade requirements.
- C. When necessary to cut and fit on site, provide materials with ample allowance for cutting and scribing.

### 2.4 ACCESSORIES

- A. Corner Guards for Wood Wall Paneling:
  - 1. Material: Extruded aluminum. Color Black
  - 2. Shape: L-shape.
  - 3. Width: 1 inch

4. Height: As indicated on Drawings.
5. Installation: As indicated on Drawings.

### PART 3 EXECUTION

#### 3.1 EXAMINATION

- A. Verify that field measurements are as indicated on shop drawings.
- B. Verify adequacy of backing and support framing.
- C. Verify mechanical, electrical, and building items affecting work of this section are placed and ready to receive this work.

#### 3.2 INSTALLATION

- A. Do not begin installation until wood materials have been fully acclimated to interior conditions.
- B. Set and secure materials and components in place, plumb and level, using concealed fasteners wherever possible.
- C. Where necessary to cut and fit on site, scribe work abutting other components. Do not use additional overlay trim to conceal gaps.
- D. Set exposed fasteners, fill with wood filler, and finish to match panel finish.
- E. Touch up damaged finish to match original, using materials provided by fabricator; replace components that cannot be refinished like new.

#### 3.3 TOLERANCES

- A. Maximum Variation from True Position: 1/16 inch.

END OF SECTION



## SECTION 07 01 50.19 - PREPARATION FOR RE-ROOFING OR ROOF REPAIR

### PART 1 GENERAL

#### 1.1 SECTION INCLUDES

- A. Partial replacement of existing roofing system in preparation for replacement roofing system in designated areas as indicated on drawings.
- B. Temporary roofing protection.

#### 1.2 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate with affected mechanical and electrical work associated with roof penetrations.

#### 1.3 SUBMITTALS

- A. Product Data: Submit for each type of material.
- B. Shop Drawings: Indicate size, configuration, and installation details.
- C. Materials Removal Company Qualification Statement.

#### 1.4 FIELD CONDITIONS

- A. Existing roofing system.
- B. Do not remove existing roofing membrane when weather conditions threaten the integrity of building contents or intended continued occupancy.
- C. Maintain continuous temporary protection prior to and during installation of new roofing system and mechanical units.
- D. Verify that occupants have been evacuated from building areas when work on structurally impaired roof decking is scheduled to begin.

### PART 2 PRODUCTS

#### 2.1 COMPONENTS

- A. Refer to following sections for additional information on components relating to this work:
  - 1. Partial removal of existing roofing system in preparation for new mechanical units in designated areas as indicated on drawings. Where existing have been partially removed to support new work, replacement roof shall have materials alike existing construction.
  - 2. Replacement of roof areas where mechanical units were removed to match adjacent construction.

#### 2.2 MATERIALS

- A. Patching Materials: Provide necessary materials in accordance with requirements of existing roofing system.
- B. Temporary Roofing Protection Materials:
  - 1. Contractor's responsibility to select appropriate materials for temporary protection of roofing areas as determined necessary for this work.

- C. Roofing Recover Materials:
  - 1. Contractor's responsibility to select appropriate materials for roofing re-cover as determined necessary for this work.

## 2.3 ACCESSORIES

- A. Fasteners: Type and size as required and compatible with existing and new roofing system to resist local wind uplift.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Verify that existing roof surface has been cleared of materials being removed from existing roofing system and ready for next phase of work as required.

### 3.2 PREPARATION

- A. Sweep roof surface clean of loose matter.
- B. Remove loose refuse and dispose of properly off-site.

### 3.3 MATERIAL REMOVAL

- A. Remove only existing roofing materials that can be replaced with new materials the same day.
- B. Remove damaged portions of roofing membrane, perimeter base flashings, flashings around roof protrusions, pitch pans and pockets.
- C. Cut and lay flat any membrane blisters.

### 3.4 INSTALLATION

- A. Coordinate scope of this work with requirements for installation of new roofing system, so that roof warranty is still maintained.

### 3.5 PROTECTION

- A. Provide protection of existing roofing system that is not having work performed on it.
- B. Provide temporary protective sheeting over uncovered deck surfaces.
- C. Turn sheeting up and over parapets and curbing. Retain sheeting in position with weights.
- D. Provide for surface drainage from sheeting to existing drainage facilities.
- E. Do not permit traffic over unprotected or repaired deck surface.
- F. Install recover board over existing membrane.

END OF SECTION

## SECTION 07 21 19 - FOAMED-IN-PLACE INSULATION

### PART 1 GENERAL

#### 1.1 SECTION INCLUDES

- A. Foamed-in-place insulation.
  - 1. In exterior framed walls.

#### 1.2 SUBMITTALS

- A. Product Data: Provide product description, insulation properties, overcoat properties, and preparation requirements.
- B. ABAA Manufacturer Qualification: Submit documentation of current evaluation of proposed manufacturer and materials.
- C. ABAA Installer Qualification: Submit documentation of current contractor accreditation and current installer certification. Keep copies of all contractor accreditation and installer certification on site during and after installation. Present on-site documentation upon request.

#### 1.3 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section, with not less than three years of documented experience.
- B. Installer Qualifications: Company specializing in performing work of the type specified, with minimum three years documented experience, and approved by manufacturer.

#### 1.4 FIELD CONDITIONS

- A. Do not apply foam when temperature is below that specified by the manufacturer for ambient air and substrate.
- B. Do not apply foam when temperature is within 5 degrees F of dew point.

### PART 2 PRODUCTS

#### 2.1 MANUFACTURERS

- A. Foamed-In-Place Insulation:
  - 1. BASF Corporation; WALLTITE US Series Closed Cell: [www.spf.basf.com/#sle](http://www.spf.basf.com/#sle).
  - 2. Carlisle Spray Foam Insulation: [www.carlisesfi.com/#sle](http://www.carlisesfi.com/#sle).
  - 3. Johns Manville; JM Corbond III Closed Cell Spray Polyurethane Foam: [www.jm.com/#sle](http://www.jm.com/#sle).

#### 2.2 MATERIALS

- A. Foamed-In-Place Insulation: Low-density, flexible, closed cell, water vapor permeable polyurethane foam; foamed on-site, using blowing agent of water or non-ozone-depleting gas.
  - 1. Regulatory Requirements: Comply with applicable code for flame and smoke, concealment, and fire protection requirements.

- a. Fire Protection: Provide 15-minute thermal barrier of 5/8 inch gypsum board or equivalent material complying with NFPA 275 test method, or foamed-in-place insulation either exposed or with covering that complies with FM 4880, NFPA 286, UL 1040, or UL 1715.
  2. Thermal Resistance: R-value of 6, minimum, per 1 inch thickness at 75 degrees F mean temperature when tested in accordance with ASTM C518.
  3. Air Permeance: 0.04 cfm per square foot, maximum, when tested at intended thickness in accordance with ASTM E2178 at 1.57 psf.
  4. Surface Burning Characteristics: Flame spread/Smoke developed index of 75/450, maximum, when tested in accordance with ASTM E84.
- B. Foamed-In-Place Insulation: Medium-density, rigid or semi-rigid, closed cell polyurethane foam; foamed on-site, using blowing agent of water or non-ozone-depleting gas.
1. Regulatory Requirements: Comply with applicable code for flame and smoke, concealment, and fire protection requirements.
    - a. Fire Protection: Provide 15-minute thermal barrier of 1/2 inch gypsum board or equivalent material complying with NFPA 275 test method, or foamed-in-place insulation either exposed or with covering that complies with FM 4880, NFPA 286, UL 1040, or UL 1715.
  2. Thermal Resistance: R-value of 5.0, minimum, per 1 inch thickness at 75 degrees F mean temperature when tested in accordance with ASTM C518.
  3. Water Vapor Permeance: Vapor retarder; 2 perms, maximum, when tested at intended thickness in accordance with ASTM E96/E96M, desiccant method.
  4. Water Absorption: Less than 2 percent by volume, maximum, when tested in accordance with ASTM D2842.
  5. Air Permeance: 0.04 cfm per square foot, maximum, when tested at intended thickness in accordance with ASTM E2178 at 1.57 psf.
  6. Closed Cell Content: At least 90 percent.
  7. Surface Burning Characteristics: Flame spread/Smoke developed index of 75/450, maximum, when tested in accordance with ASTM E84.

### 2.3 ACCESSORIES

- A. Primer: As required by insulation manufacturer.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Verify work within construction spaces or crevices is complete prior to insulation application.
- B. Verify that surfaces are clean, dry, and free of matter that may inhibit insulation or overcoat adhesion.

### 3.2 PREPARATION

- A. Mask and protect adjacent surfaces from over spray or dusting.
- B. Apply primer in accordance with manufacturer's instructions.

### 3.3 APPLICATION

- A. Apply insulation in accordance with manufacturer's instructions.
- B. Apply insulation by spray method, to a uniform monolithic density without voids.
- C. Patch damaged areas.

- D. Where applied to voids and gaps assure space for expansion to avoid pressure on adjacent materials that may bind operable parts.
- E. Trim excess away for applied trim or remove as required for continuous sealant bead.

#### 3.4 PROTECTION

- A. Do not permit subsequent construction work to disturb applied insulation.

END OF SECTION

## SECTION 07 84 00 - FIRESTOPPING

### PART 1 GENERAL

#### 1.1 SECTION INCLUDES

- A. Firestopping systems.
- B. Firestopping of joints and penetrations in fire-resistance-rated and smoke-resistant assemblies, whether indicated on drawings or not, and other openings indicated.

#### 1.2 SUBMITTALS

- A. Schedule of Firestopping: List each type of penetration, fire rating of the penetrated assembly, and firestopping test or design number.
- B. Product Data: Provide data on product characteristics, performance ratings, and limitations.
- C. Sustainable Design Submittal: Submit VOC content documentation for nonpreformed materials.
- D. Certificate from authority having jurisdiction indicating approval of materials used.
- E. Manufacturer's qualification statement.
- F. Installer's qualification statement.

#### 1.3 QUALITY ASSURANCE

- A. Fire Testing: Provide firestopping assemblies of designs that provide the scheduled fire ratings when tested in accordance with methods indicated.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

#### 1.4 FIELD CONDITIONS

- A. Comply with firestopping manufacturer's recommendations for temperature and conditions during and after installation; maintain minimum temperature before, during, and for three days after installation of materials.
- B. Provide ventilation in areas where solvent-cured materials are being installed.

### PART 2 PRODUCTS

#### 2.1 MANUFACTURERS

- A. Firestopping Manufacturers:
  - 1. 3M Fire Protection Products: [www.3m.com/firestop/#sle](http://www.3m.com/firestop/#sle).
  - 2. Hilti, Inc: [www.us.hilti.com/#sle](http://www.us.hilti.com/#sle).

## 2.2 MATERIALS

- A. Firestopping Materials: Any materials meeting requirements.
- B. Volatile Organic Compound (VOC) Content: Provide products having VOC content lower than that required by SCAQMD 1168.
- C. Primers, Sleeves, Forms, Insulation, Packing, Stuffing, and Accessories: Provide type of materials as required for tested firestopping assembly.
- D. Fire Ratings: Refer to drawings for required systems and ratings.

## 2.3 FIRESTOPPING ASSEMBLY REQUIREMENTS

- A. Perimeter Fire Containment Firestopping: Use system that has been tested according to ASTM E2307 to have fire resistance F Rating equal to required fire rating of floor assembly.
- B. Head-of-Wall (HW) Joint System Firestopping at Joints Between Fire-Rated Wall Assemblies and Non-Rated Horizontal Assemblies: Use system that has been tested according to ASTM E2837 to have fire resistance F Rating equal to required fire rating of wall assembly.
- C. Floor-to-Floor (FF), Floor-to-Wall (FW), Head-of-Wall (HW), and Wall-to-Wall (WW) Joints, Except Perimeter, Where Both Are Fire-Rated: Use system that has been tested according to ASTM E1966 or UL 2079 to have fire resistance F Rating equal to required fire rating of the assembly in which the joint occurs.
- D. Through Penetration Firestopping: Use system that has been tested according to ASTM E814 to have fire resistance F Rating equal to required fire rating of penetrated assembly.

## 2.4 FIRESTOPPING SYSTEMS

- A. Firestopping: Any material meeting requirements.
  - 1. Fire Ratings: Use system that is listed by FM (AG), ITS (DIR), or UL (FRD) and tested in accordance with ASTM E814, ASTM E119, or UL 1479 with F Rating equal to fire rating of penetrated assembly and minimum T Rating Equal to F Rating and in compliance with other specified requirements.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Verify openings are ready to receive the work of this section.

### 3.2 PREPARATION

- A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other materials that could adversely affect bond of firestopping material.
- B. Remove incompatible materials that could adversely affect bond.

- C. Install backing materials to prevent liquid material from leakage.

### 3.3 INSTALLATION

- A. Install materials in manner described in fire test report and in accordance with manufacturer's instructions, completely closing openings.
- B. Do not cover installed firestopping until inspected by authorities having jurisdiction.
- C. Install labeling required by code.

### 3.4 FIELD QUALITY CONTROL

- A. Repair or replace penetration firestopping and joints at locations where inspection results indicate firestopping or joints do not meet specified requirements.

### 3.5 CLEANING

- A. Clean adjacent surfaces of firestopping materials.

### 3.6 PROTECTION

- A. Protect adjacent surfaces from damage by material installation.

END OF SECTION



## SECTION 07 92 00 - JOINT SEALANTS

### PART 1 GENERAL

#### 1.1 SECTION INCLUDES

- A. Nonsag gunnable joint sealants.
- B. Joint backings and accessories.

#### 1.2 QUALITY ASSURANCE

- A. Maintain one copy of each referenced document covering installation requirements on site.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- C. Installer Qualifications: Company specializing in performing the work of this section and with at least three years of documented experience and approved by manufacturer.

#### 1.3 WARRANTY

- A. Correct defective work within a five year period after Date of Substantial Completion.
- B. Warranty: Include coverage for installed sealants and accessories that fail to achieve watertight seal , exhibit loss of adhesion or cohesion, or do not cure.

### PART 2 PRODUCTS

#### 2.1 MANUFACTURERS

- A. Non-Sag Sealants: Permits application in joints on vertical surfaces without sagging or slumping.
  - 1. Dow: [www.dow.com/#sle](http://www.dow.com/#sle).
  - 2. Hilti, Inc: [www.us.hilti.com/#sle](http://www.us.hilti.com/#sle).
  - 3. Pecora Corporation: [www.pecora.com/#sle](http://www.pecora.com/#sle).
  - 4. Sherwin-Williams Company: [www.sherwin-williams.com/#sle](http://www.sherwin-williams.com/#sle).
  - 5. Tremco Commercial Sealants & Waterproofing: [www.tremcosealants.com/#sle](http://www.tremcosealants.com/#sle).

#### 2.2 JOINT SEALANT APPLICATIONS

- A. Scope:
  - 1. Exterior Joints: Seal open joints, whether or not the joint is indicated on drawings, unless specifically indicated not to be sealed. Exterior joints to be sealed include, but are not limited to, the following items.
    - a. Wall expansion and control joints.
    - b. Joints between door, window, and other frames and adjacent construction.
    - c. Joints between different exposed materials.
    - d. Openings below ledge angles in masonry.
    - e. Other joints indicated below.
  - 2. Interior Joints: Do not seal interior joints unless specifically indicated to be sealed. Interior joints to be sealed include, but are not limited to, the following items.
    - a. Joints between door, window, and other frames and adjacent construction.

- b. In sound-rated wall and ceiling assemblies, gaps at electrical outlets, wiring devices, piping, and other openings; between wall/ceiling and other construction; and other flanking sound paths.
      - c. Other joints indicated below.
    3. Do not seal the following types of joints.
      - a. Intentional weepholes in masonry.
      - b. Joints indicated to be treated with manufactured expansion joint cover or some other type of sealing device.
      - c. Joints where sealant is specified to be provided by manufacturer of product to be sealed.
      - d. Joints where installation of sealant is specified in another section.
      - e. Joints between suspended panel ceilings/grid and walls.
  - B. Exterior Joints: Use non-sag non-staining silicone sealant, unless otherwise indicated.
    1. Lap Joints in Sheet Metal Fabrications: Butyl rubber, non-curing.
    2. Lap Joints between Manufactured Metal Panels: Butyl rubber, non-curing.
    3. Control and Expansion Joints in Concrete Paving: Self-leveling polyurethane "traffic-grade" sealant.
  - C. Interior Joints: Use non-sag polyurethane sealant, unless otherwise indicated.
    1. Wall and Ceiling Joints in Non-Wet Areas: Acrylic emulsion latex sealant.
    2. Wall and Ceiling Joints in Wet Areas: Non-sag polyurethane sealant for continuous liquid immersion.
    3. Floor Joints in Wet Areas: Non-sag polyurethane "non-traffic-grade" sealant suitable for continuous liquid immersion.
    4. Joints between Fixtures in Wet Areas and Floors, Walls, and Ceilings: Mildew-resistant silicone sealant; white.
    5. In Sound-Rated Assemblies: Acrylic emulsion latex sealant.
    6. Narrow Control Joints in Interior Concrete Slabs: Self-leveling epoxy sealant.
    7. Other Floor Joints: Self-leveling polyurethane "traffic-grade" sealant.
  - D. Interior Wet Areas: Bathrooms, restrooms, and kitchens; fixtures in wet areas include plumbing fixtures, food service equipment, countertops, cabinets, and other similar items.
  - E. Sound-Rated Assemblies: Walls and ceilings identified as "STC-rated", "sound-rated", or "acoustical".

### 2.3 JOINT SEALANTS - GENERAL

- A. Sealants and Primers: Provide products having lower volatile organic compound (VOC) content than indicated in SCAQMD 1168.
- B. Colors: As indicated on drawings.

### 2.4 NONSAG JOINT SEALANTS

- A. Non-Staining Silicone Sealant: ASTM C920, Grade NS, Uses M and A; not expected to withstand continuous water immersion or traffic.
  1. Movement Capability: Plus and minus 50 percent, minimum.
  2. Non-Staining to Porous Stone: Non-staining to light-colored natural stone when tested in accordance with ASTM C1248.
  3. Dirt Pick-Up: Reduced dirt pick-up compared to other silicone sealants.
- B. Silicone Sealant: ASTM C920, Grade NS, Uses M and A; not expected to withstand continuous water immersion or traffic.
  1. Movement Capability: Plus and minus 25 percent, minimum.
  2. Hardness Range: 15 to 35, Shore A, when tested in accordance with ASTM C661.
  3. Color: Match adjacent finished surfaces.
  4. Color: To be selected by Architect from manufacturer's standard range.

5. Cure Type: Single-component, neutral moisture curing
  6. Service Temperature Range: Minus 65 to 180 degrees F.
  7. Manufacturers:
    - a. Dow; DOWSIL 999-A Building and Glazing Sealant: [www.dow.com/#sle](http://www.dow.com/#sle).
    - b. Sherwin-Williams Company; Silicone Rubber All Purpose Sealant: [www.sherwin-williams.com/#sle](http://www.sherwin-williams.com/#sle).
    - c. Sika Corporation; Sikasil GP: [www.usa.sika.com/#sle](http://www.usa.sika.com/#sle).
    - d. Sika Corporation; Sikasil WS-295: [www.usa.sika.com/#sle](http://www.usa.sika.com/#sle).
    - e. Sika Corporation; Sikasil N-Plus US: [www.usa.sika.com/#sle](http://www.usa.sika.com/#sle).
    - f. Sika Corporation; Sikasil 728NS: [www.usa.sika.com/#sle](http://www.usa.sika.com/#sle).
- C. Mildew-Resistant Silicone Sealant: ASTM C920, Grade NS, Uses M and A; single component, mildew resistant; not expected to withstand continuous water immersion or traffic.
1. Color: White.
  2. Manufacturers:
    - a. ADFAST Corporation; ADSEAL KB 4800 Series: [www.adfastcorp.com/#sle](http://www.adfastcorp.com/#sle).
    - b. Everkem Diversified Products, Inc; TruSil 100: [www.everkemproducts.com/#sle](http://www.everkemproducts.com/#sle).
    - c. Pecora Corporation; Pecora 898 NST (Non-Staining Technology): [www.pecora.com/#sle](http://www.pecora.com/#sle).
    - d. Sika Corporation; Sikasil GP: [www.usa.sika.com/#sle](http://www.usa.sika.com/#sle).
- D. Polymer Sealant: ASTM C920; single component, cured sealant is paintable and mold/mildew resistant, low odor and VOC, and ultraviolet (UV) resistant.
1. Color: White.
  2. Manufacturers:
    - a. ADFAST Corporation; ADSEAL DWSP 1940 Series: [www.adfastcorp.com/#sle](http://www.adfastcorp.com/#sle).
    - b. DAP Products Inc; DYNAFLEX 800 Sealant: [www.dapspecline.com/#sle](http://www.dapspecline.com/#sle).
- E. Type \_\_\_\_ - Polyurethane Sealant: ASTM C920, Grade NS, Uses M and A; single or multi-component; not expected to withstand continuous water immersion or traffic.
1. Movement Capability: Plus and minus \_\_\_\_ percent, minimum.
- F. Type \_\_\_\_ - Polyurethane Sealant for Continuous Water Immersion: ASTM C920, Grade NS, Uses M and A; single or multi-component; explicitly approved by manufacturer for continuous water immersion; suitable for traffic exposure when recessed below traffic surface.
1. Movement Capability: Plus and minus 35 percent, minimum.

## 2.5 ACCESSORIES

- A. Backer Rod: Cylindrical cellular foam rod with surface that sealant will not adhere to, compatible with specific sealant used, and recommended by backing and sealant manufacturers for specific application.
1. Type for Joints Not Subject to Pedestrian or Vehicular Traffic: ASTM C1330; Type O - Open Cell Polyurethane.
  2. Type for Joints Subject to Pedestrian or Vehicular Traffic: ASTM C1330; Type B - Bi-Cellular Polyethylene.
  3. Open Cell: 40 to 50 percent larger in diameter than joint width.
  4. Closed Cell and Bi-Cellular: 25 to 33 percent larger in diameter than joint width.
  5. Manufacturers:
    - a. ADFAST Corporation; ADSEAL BR-2600 (Backer Rod): [www.adfastcorp.com/#sle](http://www.adfastcorp.com/#sle).
    - b. Nomaco, Inc: [www.nomaco.com/#sle](http://www.nomaco.com/#sle).
- B. Overlay Extrusion for Glazing System Joint Protection: Rubber profiled extrusions placed over joints in glazing system and provided with watertight seal.
1. Profile: As required to match existing metal glazing cap requirements.
  2. Color: As required to match existing conditions.
  3. Durometer Hardness, Type A: 65, minimum, when tested in accordance with ASTM D2240.
  4. Tensile Strength: 1139 psi, in accordance with ASTM D412.

5. Manufacturers:

- C. Backing Tape: Self-adhesive polyethylene tape with surface that sealant will not adhere to and recommended by tape and sealant manufacturers for specific application.
- D. Masking Tape: Self-adhesive, nonabsorbent, non-staining, removable without adhesive residue, and compatible with surfaces adjacent to joints and sealants.
- E. Joint Cleaner: Non-corrosive and non-staining type, type recommended by sealant manufacturer; compatible with joint forming materials.
- F. Primers: Type recommended by sealant manufacturer to suit application; non-staining.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that joints are ready to receive work.
- B. Verify that backing materials are compatible with sealants.
- C. Verify that backer rods are of the correct size.
- D. Preinstallation Adhesion Testing:
  - 1. Test each sample for adhesion.
  - 2. If any sample fails, review products and installation procedures, consult manufacturer, or take whatever other measures are necessary to ensure adhesion; re-test in a different location; if unable to obtain satisfactory adhesion, report to Architect.
  - 3. After completion of tests, remove remaining sample material and prepare joint for new sealant installation.

3.2 PREPARATION

- A. Remove loose materials and foreign matter that could impair adhesion of sealant.
- B. Clean joints, and prime as necessary, in accordance with manufacturer's instructions.
- C. Perform preparation in accordance with manufacturer's instructions and ASTM C1193.
- D. Mask elements and surfaces adjacent to joints from damage and disfigurement due to sealant work; be aware that sealant drips and smears may not be completely removable.
- E. Concrete Floor Joints That Will Be Exposed in Completed Work: Test joint filler in inconspicuous area to verify that it does not stain or discolor slab.

3.3 INSTALLATION

- A. Perform work in accordance with sealant manufacturer's requirements for preparation of surfaces and material installation instructions.
- B. Perform installation in accordance with ASTM C1193.

- C. Perform acoustical sealant application work in accordance with ASTM C919.
- D. Measure joint dimensions and size joint backers to achieve width-to-depth ratio, neck dimension, and surface bond area as recommended by manufacturer, except where specific dimensions are indicated.
- E. Install bond breaker backing tape where backer rod cannot be used.
- F. Install sealant free of air pockets, foreign embedded matter, ridges, and sags, and without getting sealant on adjacent surfaces.
- G. Do not install sealant when ambient temperature is outside manufacturer's recommended temperature range, or will be outside that range during the entire curing period, unless manufacturer's approval is obtained and instructions are followed.
- H. Nonsag Sealants: Tool surface concave, unless otherwise indicated; remove masking tape immediately after tooling sealant surface.
- I. Concrete Floor Joint Filler: After full cure, shave joint filler flush with top of concrete slab.

#### 3.4 FIELD QUALITY CONTROL

- A. Remove and replace failed portions of sealants using same materials and procedures as indicated for original installation.

#### 3.5 POST-OCCUPANCY

- A. Post-Occupancy Inspection: Perform visual inspection of entire length of project sealant joints at a time that joints have opened to their greatest width; i.e. at low temperature in thermal cycle. Report failures immediately and repair.

END OF SECTION

## SECTION 08 11 13 - HOLLOW METAL DOORS AND FRAMES

### PART 1 GENERAL

#### 1.1 SECTION INCLUDES

- A. Non-fire-rated hollow metal doors and frames.
- B. Thermally insulated hollow metal doors with frames.

#### 1.2 RELATED REQUIREMENTS

- A. Section 08 71 00 - Door Hardware.
- B. Section 08 80 00 - Glazing: Glass for doors and borrowed lites.

#### 1.3 SUBMITTALS

- A. Product Data: Materials and details of design and construction, hardware locations, reinforcement type and locations, anchorage and fastening methods, and finishes; and one copy of referenced standards/guidelines.
- B. Shop Drawings: Details of each opening, showing elevations, glazing, frame profiles, and any indicated finish requirements.
- C. Manufacturer's Certificate: Certification that products meet or exceed specified requirements.
- D. Manufacturer's Qualification Statement.
- E. Installer's Qualification Statement.

#### 1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience.
- B. Maintain at project site copies of reference standards relating to installation of products specified.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Comply with NAAMM HMMA 840 or ANSI/SDI A250.8 (SDI-100) in accordance with specified requirements.
- B. Protect with resilient packaging; avoid humidity build-up under coverings; prevent corrosion and adverse effects on factory applied painted finish.

## PART 2 PRODUCTS

### 2.1 MANUFACTURERS

- A. Hollow Metal Doors and Frames:
1. Ceco Door, an Assa Abloy Group company: [www.assaabloydss.com/#sle](http://www.assaabloydss.com/#sle).
  2. Curries, an Assa Abloy Group company: [www.assaabloydss.com/#sle](http://www.assaabloydss.com/#sle).
  3. Steelcraft, an Allegion brand: [www.allegion.com/#sle](http://www.allegion.com/#sle).

### 2.2 PERFORMANCE REQUIREMENTS

- A. Requirements for Hollow Metal Doors and Frames:
1. Steel Sheet: Comply with one or more of the following requirements; galvanized steel complying with ASTM A653/A653M, cold-rolled steel complying with ASTM A1008/A1008M, or hot-rolled pickled and oiled (HRPO) steel complying with ASTM A1011/A1011M, commercial steel (CS) Type B, for each.
  2. Accessibility: Comply with ICC A117.1 and ADA Standards.
  3. Exterior Door Top Closures: Flush end closure channel, with top and door faces aligned.
  4. Door Edge Profile: Manufacturers standard for application indicated.
  5. Glazed Lights: Non-removable stops on non-secure side; sizes and configurations as indicated on drawings. Style: Manufacturer's standard.
  6. Hardware Preparations, Selections and Locations: Comply with NAAMM HMMA 830 and NAAMM HMMA 831 or BHMA A156.115 and ANSI/SDI A250.8 (SDI-100) in accordance with specified requirements.
- B. Hollow Metal Panels: Same construction, performance, and finish as doors.
- C. Combined Requirements: If a particular door and frame unit is indicated to comply with more than one type of requirement, comply with the specified requirements for each type; for instance, an exterior door that is also indicated as being sound-rated must comply with the requirements specified for exterior doors and for sound-rated doors; where two requirements conflict, comply with the most stringent.

### 2.3 HOLLOW METAL DOORS

- A. Door Finish: Factory primed and field finished.
- B. Exterior Doors: Thermally insulated.
1. Based on SDI Standards: ANSI/SDI A250.8 (SDI-100).
    - a. Level 1 - Standard-duty.
    - b. Physical Performance Level C, 250,000 cycles; in accordance with ANSI/SDI A250.4.
    - c. Model 1 - Full Flush.
    - d. Door Face Metal Thickness: 20 gauge, 0.032 inch, minimum.
    - e. Zinc Coating: A60/ZF180 galvanized coating; ASTM A653/A653M.
  2. Door Core Material: Vertical steel stiffeners with fiberglass batts.
    - a. Foam Plastic Insulation: Manufacturer's standard board insulation with maximum flame spread index (FSI) of 75, and maximum smoke developed index (SDI) of 450 in accordance with ASTM E84, and completely enclosed within interior of door.
  3. Door Thickness: 1-3/4 inches, nominal.
  4. Door Face Sheets: Flush.
- C. Interior Doors, Non-Fire-Rated:
1. Based on SDI Standards: ANSI/SDI A250.8 (SDI-100).
    - a. Level 1 - Standard-duty.
    - b. Physical Performance Level C, 250,000 cycles; in accordance with ANSI/SDI A250.4.
    - c. Model 1 - Full Flush.

- d. Door Face Metal Thickness: 20 gauge, 0.032 inch, minimum.
2. Door Thickness: 1-3/4 inches, nominal.

## 2.4 HOLLOW METAL FRAMES

- A. Comply with standards and/or custom guidelines as indicated for corresponding door in accordance with applicable door frame requirements.
- B. Exterior Door Frames: Knock-down type.
  1. Galvanizing: Components hot-dipped zinc-iron alloy-coated (galvannealed) in accordance with ASTM A653/A653M, with A40/ZF120 coating.
  2. Frame Metal Thickness: 18 gauge, 0.042 inch, minimum.
  3. Frame Finish: Factory primed and field finished.
  4. Weatherstripping: Separate, see Section 08 71 00.
- C. Interior Door Frames, Non-Fire Rated: Full profile/continuously welded type.
  1. Terminated Stops: Provide at interior doors; closed end stop terminated 6 inch, maximum, above floor at 45 degree angle.
  2. Frame Metal Thickness: 18 gauge, 0.042 inch, minimum.
  3. Frame Finish: Factory primed and field finished.
- D. Provide mortar guard boxes for hardware cut-outs in frames to be installed in masonry or to be grouted.
- E. Frames in Masonry Walls: Size to suit masonry coursing with head member 4 inches high to fill opening without cutting masonry units.
- F. Frames Wider than 48 inches: Reinforce with steel channel fitted tightly into frame head, flush with top.

## 2.5 FINISHES

- A. Primer: Rust-inhibiting, complying with ANSI/SDI A250.10, door manufacturer's standard.
- B. Factory Finish: Complying with ANSI/SDI A250.3, manufacturer's standard coating.
  1. Color: As indicated on drawings.

## 2.6 ACCESSORIES

- A. Louvers: Roll formed steel with overlapping frame; finish same as door components ; factory-installed.
  1. In Fire-Rated Doors: UL (DIR) or ITS (DIR) listed fusible link louver, same rating as door.
  2. Style: Standard straight slat blade.
  3. Fasteners: Exposed or concealed fasteners.
- B. Door Window Frames: Door window frames with glazing securely fastened within door opening.
- C. Glazing: As specified in Section 08 80 00, factory installed.
- D. Mechanical Fasteners for Concealed Metal-to-Metal Connections: Self-drilling, self-tapping, steel with electroplated zinc finish.
- E. Grout for Frames: Mortar grout complying with ASTM C476 with maximum slump of 4 inches as measured in accordance with ASTM C143/C143M for hand troweling in place; plaster grout and thinner pumpable grout are prohibited.



- F. Silencers: Resilient rubber, fitted into drilled hole; provide three on strike side of single door, three on center mullion of pairs, and two on head of pairs without center mullions.
- G. Temporary Frame Spreaders: Provide for factory- or shop-assembled frames.

### PART 3 EXECUTION

#### 3.1 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that opening sizes and tolerances are acceptable.
- C. Verify that finished walls are in plane to ensure proper door alignment.

#### 3.2 PREPARATION

- A. Coat inside of frames to be installed in masonry or to be grouted, with bituminous coating, prior to installation.

#### 3.3 INSTALLATION

- A. Install doors and frames in accordance with manufacturer's instructions and related requirements of specified door and frame standards or custom guidelines indicated.
- B. Install prefinished frames after painting and wall finishes are complete.
- C. Coordinate frame anchor placement with wall construction.
- D. Grout frames in masonry construction, using hand trowel methods; brace frames so that pressure of grout before setting will not deform frames.
- E. Install door hardware as specified in Section 08 71 00.
  - 1. Comply with recommended practice for hardware placement of doors and frames in accordance with ANSI/SDI A250.6 or NAAMM HMMA 861.
- F. Comply with glazing installation requirements of Section 08 80 00.
- G. Coordinate installation of electrical connections to electrical hardware items.
- H. Touch up damaged factory finishes.

#### 3.4 TOLERANCES

- A. Clearances Between Door and Frame: Comply with related requirements of specified frame standards or custom guidelines indicated in accordance with SDI 117 or NAAMM HMMA 861.
- B. Maximum Diagonal Distortion: 1/16 inch measured with straight edge, corner to corner.

3.5 ADJUSTING

- A. Adjust for smooth and balanced door movement.
- B. Adjust sound control doors so that seals are fully engaged when door is closed.
- C. Test sound control doors for force to close, latch, and unlatch; adjust as necessary in compliance with requirements.

3.6 SCHEDULE

- A. Refer to Door and Frame Schedule on the drawings.

END OF SECTION

## SECTION 08 11 16 - ALUMINUM DOORS AND FRAMES

### PART 1 GENERAL

#### 1.1 SECTION INCLUDES

- A. Glazed aluminum doors.
- B. Aluminum frames.
- C. Glazing.

#### 1.2 RELATED REQUIREMENTS

- A. Section 08 71 00 - Door Hardware: Hardware for aluminum doors.
- B. Section 08 80 00 - Glazing: Glazing materials for aluminum doors and frames.

#### 1.3 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Manufacturer's descriptive literature for each type of door; include information on fabrication methods.
- C. Shop Drawings: Include elevations of each opening type.
  - 1. Verify dimensions by field measurements before fabrication and indicate on shop drawings.
- D. Selection Samples: Complete set of color and finish options, using actual materials, for Architect's selection.
- E. Verification Samples: Actual pieces of products in each finish specified, not less than 6 inches square or 6 inches long for linear components. For finishes subject to color variation, include not less than two samples illustrating extreme range to be anticipated.
- F. Test Report: Submit certified test reports from qualified independent testing agency indicating doors comply with specified performance requirements.
- G. Manufacturer's qualification statement.
- H. Installer's qualification statement.
- I. Field Quality Control Submittals: Report of field testing for water penetration and air leakage.
- J. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

#### 1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with not less than five years of documented experience.
- B. Installer Qualifications: Company specializing in performing work of type specified and with at least three years of documented experience.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver aluminum components in manufacturer's standard protective packaging, palleted, crated, or banded together.
- B. Inspect delivered components for damage and replace. Repaired components will not be accepted.
- C. Store components in clean, dry, indoor area, under cover in manufacturer's packaging until installation.
- D. Protect materials and finish from damage during handling and installation.

#### 1.6 FIELD CONDITIONS

- A. Do not begin installation of interior aluminum components until space has been enclosed and ambient thermal conditions are being maintained at levels consistent with final project requirements.

#### 1.7 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.
- B. Correct defective Work within a five year period after Date of Substantial Completion.
- C. Provide ten year manufacturer warranty for defects in workmanship and materials.

### PART 2 PRODUCTS

#### 2.1 MANUFACTURERS

- A. Glazed Aluminum Doors:
  - 1. Andersen; Inswing Aluminum Pivot Door: [www.andersenwindows.com/#sle](http://www.andersenwindows.com/#sle).
  - 2. Avalon International Aluminum LLC; Eagle Universal System: [www.avalonint.com/#sle](http://www.avalonint.com/#sle).
  - 3. Wilson Partitions: [www.wilsonpart.com/#sle](http://www.wilsonpart.com/#sle).
- B. Aluminum Frames:
  - 1. Arcadia, Inc: [www.arcadiainc.com/#sle](http://www.arcadiainc.com/#sle).
  - 2. Avalon International Aluminum LLC; Eagle Series Door Frames and Sidelights: [www.avalonint.com/#sle](http://www.avalonint.com/#sle).
  - 3. Cline Aluminum Doors, Inc: [www.clinedoors.com/#sle](http://www.clinedoors.com/#sle).
  - 4. Wilson Partitions: [www.wilsonpart.com/#sle](http://www.wilsonpart.com/#sle).

#### 2.2 DOORS AND FRAMES

- A. Accessibility: Comply with ICC A117.1 and ADA Standards.

- B. Glazed Aluminum Doors: Extruded aluminum tube frame, full glazed, with middle rail; factory glazed.
  - 1. Thickness: 1-3/4 inches, nominal.
  - 2. Stile Width: 5 inches, nominal.
  - 3. Finish: Class I - Natural anodized.
  - 4. Texture: Smooth.
  - 5. Seals: Manufacturer's standard.
  - 6. Manufacturer's Door Hardware: Manufacturer's standard.
    - a. Hanging Devices: Butt hinges.
- C. Aluminum Frames for Doors, Sidelights, or Transoms: Extruded aluminum, non-thermally broken hollow or C-shaped sections; no steel components.
  - 1. Frame Depth: 4-1/4 inches.
  - 2. Finish: Same as doors.
- D. Dimensions and Shapes: As indicated on drawings; dimensions indicated are nominal.
  - 1. Provide louvers as indicated on drawings.
  - 2. Provide vision lites as indicated on drawings.
  - 3. Provide the following clearances:
    - a. Hinge and Lock Stiles: 1/8 inch.
    - b. Between Meeting Stiles: 1/4 inch.
    - c. At Top Rail and Bottom Rail: 1/8 inch.

### 2.3 COMPONENTS

- A. Frames: Extruded aluminum shapes, not less than 0.062 inch thick, reinforced at hinge and strike locations.
  - 1. Corner Brackets: Extruded aluminum, fastened with stainless steel screws.
  - 2. Trim: Extruded aluminum, not less than 0.062 inch thick, removable snap-in type without exposed fasteners.
- B. Vision Lites: Extruded aluminum framed, gasket glazed.
  - 1. Glazing: See Section 08 80 00.
- C. Replaceable Weatherstripping: AAMA 701/702 wool pile.

### 2.4 PERFORMANCE REQUIREMENTS

- A. Provide door assemblies that have been designed and fabricated in compliance with specified performance requirements.
- B. Wind-Borne-Debris Resistance: Identical full-size glazed assembly without auxiliary protection, tested by independent agency in accordance with ASTM E1996 and Wind Zone 4 - Additional Protection for Large and Small Missile impact and pressure cycling at design wind pressure.
- C. Water Leakage: No uncontrolled leakage on interior face when tested in accordance with ASTM E331 at differential pressure of 7.5 psf.
- D. Air Leakage: Maximum of 0.1 cu ft/min/sq ft at 6.27 psf differential pressure, when tested in accordance with ASTM E283/E283M.
- E. Condensation Resistance Factor: 50, measured in accordance with AAMA 1503.

- F. Overall U-value, Including Glazing: 0.35, minimum, measured on exterior door size required for this project.
- G. Acoustical Performance: Sound Transmission Class (STC) of 25, minimum, when tested in accordance with ASTM E90.

## 2.5 MATERIALS

- A. Aluminum Sheet: ASTM B209/B209M, alloy 5005, temper H14, stretcher leveled.
- B. Extruded Aluminum: ASTM B221 (ASTM B221M), alloy 6063, temper T5, or alloy 6463, temper T5.

## 2.6 FINISHES

- A. Class I Color Anodized Finish: Electrolytically deposited colored anodic coating; AAMA 611 AA-M12C22A44, minimum dry film thickness (DFT) of 0.7 mils, 0.0007 inch.
- B. Color: As indicated on drawings.
- C. Touch-Up Materials: As recommended by coating manufacturer for field application.

## 2.7 ACCESSORIES

- A. Fasteners: Aluminum, non-magnetic stainless steel, or other material warranted by manufacturer as non-corrosive and compatible with aluminum components.
- B. Brackets and Reinforcements: Manufacturer's high-strength aluminum units where feasible, otherwise, non-magnetic stainless steel or steel hot-dip galvanized in compliance with ASTM A123/A123M.
- C. Bituminous Coating: Cold-applied asphaltic mastic, compounded for 30-mil thickness per coat.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Verify that wall surfaces and openings are ready to receive frames and are within tolerances specified in manufacturer's instructions.
- B. Verify that frames installed by other trades for installation of doors of this section are in strict accordance with recommendations and approved shop drawings and within tolerances specified in manufacturer's instructions.
- C. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

### 3.2 PREPARATION

- A. Perform cutting, fitting, forming, drilling, and grinding of frames as required for project conditions.
- B. Replace components with damage to exposed finishes.

- C. Separate dissimilar metals to prevent electrolytic action between metals.

### 3.3 INSTALLATION

- A. Install doors and frames in accordance with manufacturer's instructions and approved shop drawings.
- B. Install exterior doors and frames in accordance with ASTM E2112.
- C. Set frames plumb, square, level, and aligned to receive doors. Anchor frames to adjacent construction in strict accordance with manufacturer's recommendations and within specified tolerances.
- D. Where aluminum surfaces contact metals other than stainless steel, zinc, or small areas of white bronze, protect from direct contact by painting dissimilar metal with heavy coating of bituminous paint.
- E. Hang doors and adjust hardware to achieve specified clearances and proper door operation.
- F. Install door hardware, see Section 08 71 00.
- G. Install glazing; set glazing stops and glazing gaskets flush with face of door or frame.
- H. Comply with glazing installation requirements, see Section 08 80 00.

### 3.4 FIELD QUALITY CONTROL

- A. Provide services of aluminum door manufacturer's field representative to observe for proper installation of system and submit report.

### 3.5 CLEANING

- A. Upon completion of installation, thoroughly clean door and frame surfaces in accordance with AAMA 609 & 610.
- B. Do not use abrasive, caustic, or acid cleaning agents.

### 3.6 PROTECTION

- A. Protect products of this section from damage caused by subsequent construction until Date of Substantial Completion.
- B. Replace damaged or defective components that cannot be repaired to a condition indistinguishable from undamaged components.

END OF SECTION

## SECTION 08 43 13 - ALUMINUM-FRAMED STOREFRONTS

### PART 1 GENERAL

#### 1.1 SECTION INCLUDES

- A. Aluminum-framed storefront, with vision glass.
- B. Aluminum doors and frames.
- C. Weatherstripping.

#### 1.2 RELATED REQUIREMENTS

- A. Section 08 71 00 - Door Hardware: Hardware items other than specified in this section.
- B. Section 08 80 00 - Glazing: Glass and glazing accessories.

#### 1.3 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate with installation of other components that comprise the exterior enclosure.

#### 1.4 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide component dimensions, describe components within assembly, anchorage and fasteners, glass and infill, door hardware, and internal drainage details.
- C. Shop Drawings: Indicate system dimensions, framed opening requirements and tolerances, affected related work, expansion and contraction joint location and details, and field welding required.
- D. Design Data: Provide framing member structural and physical characteristics, engineering calculations, and dimensional limitations.
- E. Hardware Schedule: Complete itemization of each item of hardware to be provided for each door, cross-referenced to door identification numbers in Contract Documents.
- F. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

#### 1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in performing work of type specified and with at least three years of documented experience.
- B. Installer Qualifications: Company specializing in performing work of type specified and with at least three years of documented experience.



## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Handle products of this section in accordance with AAMA CW-10.
- B. Protect finished aluminum surfaces with wrapping. Do not use adhesive papers or sprayed coatings that bond to aluminum when exposed to sunlight or weather.

## 1.7 FIELD CONDITIONS

- A. Do not install sealants when ambient temperature is less than 40 degrees F. Maintain this minimum temperature during and 48 hours after installation.

## 1.8 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.
- B. Correct defective Work within a five year period after Date of Substantial Completion.
- C. Provide five year manufacturer warranty against failure of glass seal on insulating glass units, including interpane dusting or misting. Include provision for replacement of failed units.
- D. Provide five year manufacturer warranty against excessive degradation of exterior finish. Include provision for replacement of units with excessive fading, chalking, or flaking.

## PART 2 PRODUCTS

### 2.1 MANUFACTURERS

- A. Aluminum-Framed Storefronts Manufacturers:
  - 1. Kawneer North America: [www.kawneer.com/#sle](http://www.kawneer.com/#sle).
  - 2. Tubelite, Inc: [www.tubeliteinc.com/#sle](http://www.tubeliteinc.com/#sle).

### 2.2 ALUMINUM-FRAMED STOREFRONT

- A. Aluminum-Framed Storefront: Factory fabricated, factory finished aluminum framing members with infill, and related flashings, anchorage and attachment devices.
  - 1. Unitized, shop assembly.
  - 2. Glazing Position: Centered (front to back).
  - 3. Finish: Color anodized with organic seal.
    - a. Factory finish all surfaces that will be exposed in completed assemblies.
    - b. Touch-up surfaces cut during fabrication so that no natural aluminum is visible in completed assemblies, including joint edges.
    - c. Coat concealed metal surfaces that will be in contact with cementitious materials or dissimilar metals with bituminous paint.
  - 4. Finish Color: Black.
  - 5. Fabrication: Joints and corners flush, hairline, and weatherproof, accurately fitted and secured; prepared to receive anchors and hardware; fasteners and attachments concealed from view; reinforced as required for imposed loads.
  - 6. Construction: Eliminate noises caused by wind and thermal movement, prevent vibration harmonics, and prevent "stack effect" in internal spaces.
  - 7. System Internal Drainage: Drain to the exterior by means of a weep drainage network any water entering joints, condensation occurring in glazing channel, and migrating moisture occurring within system.

8. Expansion/Contraction: Provide for expansion and contraction within system components caused by cycling temperature range of 170 degrees F over a 12 hour period without causing detrimental effect to system components, anchorages, and other building elements.
9. Movement: Allow for movement between storefront and adjacent construction, without damage to components or deterioration of seals.
10. Perimeter Clearance: Minimize space between framing members and adjacent construction while allowing expected movement.
11. Maintain continuous air barrier and/or vapor retarder seal throughout assembly, primarily in line with inside pane of glazing and inner sheet of infill panel, and heel bead of glazing compound.

B. Performance Requirements

1. Wind Loads: Design and size components to withstand the specified load requirements without damage or permanent set, when tested in accordance with ASTM E330/E330M, using loads 1.5 times the design wind loads and 10 second duration of maximum load.
  - a. Member Deflection: Limit member deflection to flexure limit of glass in any direction, with full recovery of glazing materials.
2. Water Penetration Resistance on Manufactured Assembly: No uncontrolled water on interior face, when tested in accordance with ASTM E331 at pressure differential of 8 psf.
3. Air Leakage: 0.06 cfm/sq ft maximum leakage of storefront wall area when tested in accordance with ASTM E283/E283M at 1.57 psf pressure difference.

2.3 COMPONENTS

A. Aluminum Framing Members: Tubular aluminum sections, drainage holes and internal weep drainage system.

1. Framing members for interior applications need not be thermally broken.
2. Glazing Stops: Flush.

B. Glazing: See Section 08 80 00.

C. Swing Doors: Glazed aluminum.

1. Thickness: 1-3/4 inches.
2. Top Rail: 4 inches wide.
3. Vertical Stiles: 4-1/2 inches wide.
4. Bottom Rail: 10 inches wide.
5. Glazing Stops: Square.
6. Finish: Same as storefront.

2.4 MATERIALS

A. Extruded Aluminum: ASTM B221 (ASTM B221M).

B. Fasteners: Stainless steel.

C. Exposed Flashings: Aluminum sheet, 20 gauge, 0.032 inch minimum thickness; finish to match framing members.

D. Concealed Flashings: Sheet aluminum, 26 gauge, 0.017 inch minimum thickness.

E. Sill Flashing Sealant: Elastomeric, silicone or polyurethane, compatible with flashing material.

F. Sealant for Setting Thresholds: Non-curing butyl type.

G. Glazing Gaskets: Type to suit application to achieve weather, moisture, and air infiltration requirements.

- H. Glazing Accessories: See Section 08 80 00.
- I. Shop and Touch-Up Primer for Steel Components: Zinc oxide, alkyd, linseed oil primer appropriate for use over hand cleaned steel.
- J. Touch-Up Primer for Galvanized Steel Surfaces: SSPC-Paint 20, zinc rich.

## 2.5 FINISHES

- A. Color Anodized Finish with Organic Seal: AAMA 612 Electrolytically deposited colored anodic coating with non-aqueous electro-deposited organic seal; not less 0.7 mils.
- B. Color: As indicated on drawings.
- C. Touch-Up Materials: As recommended by coating manufacturer for field application.

## 2.6 HARDWARE

- A. For each door, include weatherstripping, sill sweep strip, and threshold.
- B. Other Door Hardware: See Section 08 71 00.
- C. Weatherstripping: Wool pile, continuous and replaceable; provide on all doors.
- D. Sill Sweep Strips: Resilient seal type, retracting, of neoprene; provide on all doors.
- E. Threshold: Extruded aluminum, one piece per door opening, ribbed surface; provide on all doors.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Verify dimensions, tolerances, and method of attachment with other work.
- B. Verify that storefront wall openings and adjoining water-resistive and/or air barrier seal materials are ready to receive work of this section.

### 3.2 INSTALLATION

- A. Install wall system in accordance with manufacturer's instructions.
- B. Attach to structure to permit sufficient adjustment to accommodate construction tolerances and other irregularities.
- C. Provide alignment attachments and shims to permanently fasten system to building structure.
- D. Align assembly plumb and level, free of warp or twist. Maintain assembly dimensional tolerances, aligning with adjacent work.
- E. Provide thermal isolation where components penetrate or disrupt building insulation.

- F. Install sill flashings. Turn up ends and edges; seal to adjacent work to form water tight dam.
- G. Where fasteners penetrate sill flashings, make watertight by seating and sealing fastener heads to sill flashing.
- H. Pack fibrous insulation in shim spaces at perimeter of assembly to maintain continuity of thermal barrier.
- I. Set thresholds in bed of sealant and secure.
- J. Touch-up minor damage to factory applied finish; replace components that cannot be satisfactorily repaired.

### 3.3 TOLERANCES

- A. Maximum Variation from Plumb: 0.06 inch per 3 feet non-cumulative or 0.06 inch per 10 feet, whichever is less.
- B. Maximum Misalignment of Two Adjoining Members Abutting in Plane: 1/32 inch.

### 3.4 FIELD QUALITY CONTROL

- A. Provide services of storefront manufacturer's field representative to observe for proper installation of system and submit report.

### 3.5 ADJUSTING

- A. Adjust operating hardware and sash for smooth operation.

### 3.6 CLEANING

- A. Remove protective material from pre-finished aluminum surfaces.
- B. Wash down surfaces with a solution of mild detergent in warm water, applied with soft, clean wiping cloths, and take care to remove dirt from corners and to wipe surfaces clean.
- C. Upon completion of installation, thoroughly clean aluminum surfaces in accordance with AAMA 609 & 610.

### 3.7 PROTECTION

- A. Protect installed products from damage until Date of Substantial Completion.

END OF SECTION

## SECTION 08 71 00 - DOOR HARDWARE

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes:
  - 1. Mechanical and electrified door hardware
  - 2. Electronic access control system components
- B. Section excludes:
  - 1. Windows
  - 2. Cabinets (casework), including locks in cabinets
  - 3. Signage
  - 4. Toilet accessories
  - 5. Overhead doors
- C. Related Sections:
  - 1. Division 01 "General Requirements" sections for Allowances, Alternates, Owner Furnished Contractor Installed, Project Management and Coordination.
  - 2. Division 07 Section "Joint Sealants" for sealant requirements applicable to threshold installation specified in this section.
  - 3. Division 08 Sections:
    - a. "Hollow Metal Doors and Frames"
    - b. "Aluminum Doors and Frames"
    - c. "Aluminum-Framed Storefronts"
  - 4. Division 26 "Electrical" sections for connections to electrical power system and for low-voltage wiring.
  - 5. Division 28 "Electronic Safety and Security" sections for coordination with other components of electronic access control system and fire alarm system.

#### 1.2 SUBMITTALS

- A. General:
  - 1. Submit in accordance with Conditions of Contract and Division 01 Submittal Procedures.
  - 2. Prior to forwarding submittal:
    - a. Review drawings and Sections from related trades to verify compatibility with specified hardware.
    - b. Highlight, encircle, or otherwise specifically identify on submittals: deviations from Contract Documents, issues of incompatibility or other issues which may detrimentally affect the Work.
- B. Action Submittals:
  - 1. Product Data: Submit technical product data for each item of door hardware, installation instructions, maintenance of operating parts and finish, and other information necessary to show compliance with requirements.
  - 2. Riser and Wiring Diagrams: After final approval of hardware schedule, submit details of electrified door hardware, indicating:
    - a. Wiring Diagrams: For power, signal, and control wiring and including:
      - 1) Details of interface of electrified door hardware and building safety and security systems.
      - 2) Schematic diagram of systems that interface with electrified door hardware.
      - 3) Point-to-point wiring.
      - 4) Risers.

3. Samples for Verification: If requested by Architect, submit production sample of requested door hardware unit in finish indicated and tagged with full description for coordination with schedule.
    - a. Samples will be returned to supplier. Units that are acceptable to Architect may, after final check of operations, be incorporated into Work, within limitations of key coordination requirements.
  4. Door Hardware Schedule:
    - a. Submit concurrent with submissions of Product Data, Samples, and Shop Drawings. Coordinate submission of door hardware schedule with scheduling requirements of other work to facilitate fabrication of other work critical in Project construction schedule.
    - b. Submit under direct supervision of a Door Hardware Institute (DHI) certified Architectural Hardware Consultant (AHC) or Door Hardware Consultant (DHC) with hardware sets in vertical format as illustrated by Sequence of Format for the Hardware Schedule published by DHI.
    - c. Indicate complete designations of each item required for each opening, include:
      - 1) Door Index: door number, heading number, and Architect's hardware set number.
      - 2) Quantity, type, style, function, size, and finish of each hardware item.
      - 3) Name and manufacturer of each item.
      - 4) Fastenings and other pertinent information.
      - 5) Location of each hardware set cross-referenced to indications on Drawings.
      - 6) Explanation of all abbreviations, symbols, and codes contained in schedule.
      - 7) Mounting locations for hardware.
      - 8) Door and frame sizes and materials.
      - 9) Degree of door swing and handing.
      - 10) Operational Description of openings with electrified hardware covering egress, ingress (access), and fire/smoke alarm connections.
  5. Key Schedule:
    - a. After Keying Conference, provide keying schedule that includes levels of keying, explanations of key system's function, key symbols used, and door numbers controlled.
    - b. Use ANSI/BHMA A156.28 "Recommended Practices for Keying Systems" as guideline for nomenclature, definitions, and approach for selecting optimal keying system.
    - c. Provide 3 copies of keying schedule for review prepared and detailed in accordance with referenced DHI publication. Include schematic keying diagram and index each key to unique door designations.
    - d. Index keying schedule by door number, keyset, hardware heading number, cross keying instructions, and special key stamping instructions.
    - e. Provide one complete bitting list of key cuts and one key system schematic illustrating system usage and expansion. Forward bitting list, key cuts and key system schematic directly to Owner, by means as directed by Owner.
    - f. Prepare key schedule by or under supervision of supplier, detailing Owner's final keying instructions for locks.
- C. Informational Submittals:
1. Provide Qualification Data for Supplier, Installer and Architectural Hardware Consultant.
  2. Provide Product Data:
    - a. Certify that door hardware approved for use on types and sizes of labeled fire-rated doors complies with listed fire-rated door assemblies.
    - b. Include warranties for specified door hardware.
- D. Closeout Submittals:
1. Operations and Maintenance Data: Provide in accordance with Division 01 and include:
    - a. Complete information on care, maintenance, and adjustment; data on repair and replacement parts, and information on preservation of finishes.
    - b. Catalog pages for each product.
    - c. Final approved hardware schedule edited to reflect conditions as installed.
    - d. Final keying schedule
    - e. Copy of warranties including appropriate reference numbers for manufacturers to identify project.
    - f. As-installed wiring diagrams for each opening connected to power, both low voltage and 110 volts.

- E. Inspection and Testing:
  - 1. Submit written reports to the Owner and Authority Having Jurisdiction (AHJ) of the results of functional testing and inspection for:
    - a. Fire door assemblies, in compliance with NFPA 80.
    - b. Required egress door assemblies, in compliance with NFPA 101.

### 1.3 QUALITY ASSURANCE

- A. Qualifications and Responsibilities:
  - 1. Supplier: Recognized architectural hardware supplier with a minimum of 5 years documented experience supplying both mechanical and electromechanical door hardware similar in quantity, type, and quality to that indicated for this Project. Supplier to be recognized as a factory direct distributor by the manufacturer of the primary materials with a warehousing facility in the Project's vicinity. Supplier to have on staff, a certified Architectural Hardware Consultant (AHC) or Door Hardware Consultant (DHC) available to Owner, Architect, and Contractor, at reasonable times during the Work for consultation.
  - 2. Installer: Qualified tradesperson skilled in the application of commercial grade hardware with experience installing door hardware similar in quantity, type, and quality as indicated for this Project.
  - 3. Architectural Hardware Consultant: 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 meets these requirements:
    - a. For door hardware: DHI certified AHC or DHC.
    - b. Can provide installation and technical data to Architect and other related subcontractors.
    - c. Can inspect and verify components are in working order upon completion of installation.
    - d. Capable of producing wiring diagram and coordinating installation of electrified hardware with Architect and electrical engineers.
  - 4. Single Source Responsibility: Obtain each type of door hardware from single manufacturer.
- B. Certifications:
  - 1. Fire-Rated Door Openings:
    - a. Provide door hardware for fire-rated openings that complies with NFPA 80 and requirements of authorities having jurisdiction.
    - b. Provide only items of door hardware that are listed products tested by UL LLC, Intertek Testing Services, or other testing and inspecting organizations acceptable to authorities having jurisdiction for use on types and sizes of doors indicated, based on testing at positive pressure and according to NFPA 252 or UL 10C and in compliance with requirements of fire-rated door and door frame labels.
  - 2. Smoke and Draft Control Door Assemblies:
    - a. Provide door hardware that meets requirements of assemblies tested according to UL 1784 and installed in compliance with NFPA 105
    - b. Comply with the maximum air leakage of 0.3 cfm/sq. ft. (3 cu. m per minute/sq. m) at tested pressure differential of 0.3-inch wg (75 Pa) of water.
  - 3. Electrified Door Hardware
    - a. Listed and labeled as defined in NFPA 70, Article 100, by testing agency acceptable to authorities having jurisdiction.
  - 4. Accessibility Requirements:
    - a. Comply with governing accessibility regulations cited in "REFERENCES" article 087100, 1.02.D3 herein for door hardware on doors in an accessible route. This project must comply with all Federal Americans with Disability Act regulations and all Local Accessibility Regulations.
- C. Pre-Installation Meetings
  - 1. Keying Conference
    - a. Incorporate keying conference decisions into final keying schedule after reviewing door hardware keying system including:
      - 1) Function of building, flow of traffic, purpose of each area, degree of security required, and plans for future expansion.
      - 2) Preliminary key system schematic diagram.
      - 3) Requirements for key control system.
      - 4) Requirements for access control.
      - 5) Address for delivery of keys.

2. Pre-installation Conference
  - a. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
  - b. Inspect and discuss preparatory work performed by other trades.
  - c. Inspect and discuss electrical roughing-in for electrified door hardware.
  - d. Review sequence of operation for each type of electrified door hardware.
  - e. Review required testing, inspecting, and certifying procedures.
  - f. Review questions or concerns related to proper installation and adjustment of door hardware.
3. Electrified Hardware Coordination Conference:
  - a. Prior to ordering electrified hardware, schedule and hold meeting to coordinate door hardware with security, electrical, doors and frames, and other related suppliers.

#### 1.4 DELIVERY, STORAGE, AND HANDLING

- A. Inventory door hardware on receipt and provide secure lock-up for hardware delivered to Project site. Promptly replace products damaged during shipping.
- B. Tag each item or package separately with identification coordinated with final door hardware schedule, and include installation instructions, templates, and necessary fasteners with each item or package. Deliver each article of hardware in manufacturer's original packaging.
- C. Maintain manufacturer-recommended environmental conditions throughout storage and installation periods.
- D. Provide secure lock-up for door hardware delivered to Project. Control handling and installation of hardware items so that completion of Work will not be delayed by hardware losses both before and after installation.
- E. Handle hardware in manner to avoid damage, marring, or scratching. Correct, replace or repair products damaged during Work. Protect products against malfunction due to paint, solvent, cleanser, or any chemical agent.
- F. Deliver keys to manufacturer of key control system for subsequent delivery to Owner.

#### 1.5 COORDINATION

- A. Coordinate layout and installation of floor-recessed door hardware with floor construction. Cast anchoring inserts into concrete.
- B. Installation Templates: Distribute for doors, frames, and other work specified to be factory or shop prepared. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.
- C. Security: Coordinate installation of door hardware, keying, and access control with Owner's security consultant.
- D. Electrical System Roughing-In: Coordinate layout and installation of electrified door hardware with connections to power supplies and building safety and security systems.



## 1.6 WARRANTY

- A. Manufacturer's standard form in which manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within published warranty period.
  - 1. Warranty does not cover damage or faulty operation due to improper installation, improper use or abuse.
  - 2. Warranty Period: Beginning from date of Substantial Completion, for durations indicated in manufacturer's published listings.

## 1.7 MAINTENANCE

- A. Furnish complete set of special tools required for maintenance and adjustment of hardware, including changing of cylinders.
- B. Turn over unused materials to Owner for maintenance purposes.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. The Owner requires use of certain products for their unique characteristics and project suitability to ensure continuity of existing and future performance and maintenance standards. After investigating available product offerings, the Awarding Authority has elected to prepare proprietary specifications. These products are specified with the notation: "No Substitute."
  - 1. Where "No Substitute" is noted, submittals and substitution requests for other products will not be considered.
- B. Approval of alternate manufacturers and/or products other than those listed as "Scheduled Manufacturer" or "Acceptable Manufacturers" in the individual article for the product category are only to be considered by official substitution request in accordance with section 01 25 13.
- C. Approval of products from manufacturers indicated in "Acceptable Manufacturers" is contingent upon those products providing all functions and features and meeting all requirements of scheduled manufacturer's product.
- D. Where specified hardware is not adaptable to finished shape or size of members requiring hardware, furnish suitable types having same operation and quality as type specified, subject to Architect's approval.

### 2.2 MATERIALS

- A. Fabrication
  - 1. Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. provide screws according to manufacturer's recognized installation standards for application intended.
  - 2. Finish exposed screws to match hardware finish, or, if exposed in surfaces of other work, to match finish of this other work including prepared for paint surfaces to receive painted finish.
  - 3. Provide concealed fasteners wherever possible for hardware units exposed when door is closed. Coordinate with "Metal Doors and Frames", "Flush Wood Doors", "Stile and Rail Wood Doors" to ensure proper reinforcements. Advise the Architect where visible fasteners, such as thru bolts, are required.
- B. Provide screws, bolts, expansion shields, drop plates and other devices necessary for hardware installation.
  - 1. Where fasteners are exposed to view: Finish to match adjacent door hardware material.
- C. Cable and Connectors:
  - 1. Where scheduled in the hardware sets, provide each item of electrified hardware and wire harnesses with number and gage of wires enough to accommodate electric function of specified hardware.

2. Provide Molex connectors that plug directly into connectors from harnesses, electric locking and power transfer devices.
3. Provide through-door wire harness for each electrified locking device installed in a door and wire harness for each electrified hinge, electrified continuous hinge, electrified pivot, and electric power transfer for connection to power supplies.

## 2.3 HINGES

- A. Manufacturers and Products:
1. Scheduled Manufacturer and Product:
    - a. Ives 5BB series
  2. Acceptable Manufacturers and Products:
    - a. McKinney TB series
    - b. Best FBB series
- B. Requirements:
1. Provide hinges conforming to ANSI/BHMA A156.1.
  2. Provide five knuckle, ball bearing hinges.
  3. 1-3/4 inch (44 mm) thick doors, up to and including 36 inches (914 mm) wide:
    - a. Exterior: Standard weight, bronze or stainless steel, 4-1/2 inches (114 mm) high
    - b. Interior: Standard weight, steel, 4-1/2 inches (114 mm) high
  4. 1-3/4 inch (44 mm) thick doors over 36 inches (914 mm) wide:
    - a. Exterior: Heavy weight, bronze/stainless steel, 5 inches (127 mm) high
    - b. Interior: Heavy weight, steel, 5 inches (127 mm) high
  5. 2 inches or thicker doors:
    - a. Exterior: Heavy weight, bronze or stainless steel, 5 inches (127 mm) high
    - b. Interior: Heavy weight, steel, 5 inches (127 mm) high
  6. Adjust hinge width for door, frame, and wall conditions to allow proper degree of opening.
  7. Provide three hinges per door leaf for doors 90 inches (2286 mm) or less in height, and one additional hinge for each 30 inches (762 mm) of additional door height.
  8. Hinge Pins: Except as otherwise indicated, provide hinge pins as follows:
    - a. Steel Hinges: Steel pins
    - b. Non-Ferrous Hinges: Stainless steel pins
    - c. Out-Swinging Exterior Doors: Non-removable pins
    - d. Out-Swinging Interior Lockable Doors: Non-removable pins
    - e. Interior Non-lockable Doors: Non-rising pins

## 2.4 CONTINUOUS HINGES

- A. Manufacturers:
1. Scheduled Manufacturer:
    - a. Select
  2. Acceptable Manufacturers:
    - a. No Substitute
- B. Requirements:
1. Provide aluminum geared continuous hinges conforming to ANSI/BHMA A156.26, Grade 1.
  2. Provide aluminum geared continuous hinges, where specified in the hardware sets, fabricated from 6063-T6 aluminum.
  3. Provide split nylon bearings at each hinge knuckle for quiet, smooth, self-lubricating operation.
  4. Provide hinges capable of supporting door weights up to 450 pounds, and successfully tested for 1,500,000 cycles.
  5. On fire-rated doors, provide aluminum geared continuous hinges classified for use on rated doors by testing agency acceptable to authority having jurisdiction.
  6. Provide aluminum geared continuous hinges with electrified option scheduled in the hardware sets. Provide with number and gage of wires enough to accommodate electric function of specified hardware.
  7. Provide hinges 1 inch (25 mm) shorter in length than nominal height of door, unless otherwise noted or door details require shorter length and with symmetrical hole pattern.

## 2.5 ELECTRIC POWER TRANSFER

### A. Manufacturers:

1. Scheduled Manufacturer and Product:
  - a. Von Duprin EPT-10
2. Acceptable Manufacturers and Products:
  - a. ABH PT1000
  - b. Security Door Controls PTM

### B. Requirements:

1. Provide power transfer with electrified options as scheduled in the hardware sets. Provide with number and gage of wires enough to accommodate electric function of specified hardware.
2. Locate electric power transfer per manufacturer's template and UL requirements, unless interference with operation of door or other hardware items.

## 2.6 MORTISE LOCKS

### A. Manufacturers and Products:

1. Scheduled Manufacturer and Product:
  - a. Schlage L9000 series
2. Acceptable Manufacturers and Products:
  - a. No Substitute

### B. Requirements:

1. Provide mortise locks conforming to ANSI/BHMA A156.13 Series 1000, Grade 1, and UL Listed for 3-hour fire doors.
2. Indicators: Where specified, provide indicator window measuring a minimum 2-3/5-inch x 3/5 inch with 180-degree visibility. Provide messages color-coded using ANSI Z535 Safety Red with full text and/or symbols, as scheduled, for easy visibility. When applicable allows for lock status indication on both sides of the door.
3. Provide locks manufactured from heavy gauge steel, containing components of steel with a zinc dichromate plating for corrosion resistance.
4. Provide lock case that is multi-function and field reversible for handing without opening case. Cylinders: Refer to "KEYING" article, herein.
5. Provide locks with standard 2-3/4 inches (70 mm) backset with full 3/4 inch (19 mm) throw stainless steel mechanical anti-friction latchbolt. Provide deadbolt with full 1-inch (25 mm) throw, constructed of stainless steel.
6. Provide standard ASA strikes unless extended lip strikes are necessary to protect trim. Provide electrified options as scheduled in the hardware sets. Where scheduled, provide switches and sensors integrated into the locks and latches.
7. Provide motor based electrified locksets that comply with the following requirements:
  - a. Universal input voltage – single chassis accepts 12 or 24VDC to allow for changes in the field without changing lock chassis.
  - b. Fail Safe/Fail Secure – changing mode between electrically locked (fail safe) and electrically unlocked (fail secure) is field selectable without opening the lock case.
  - c. Low maximum current draw – maximum 0.4 amps to allow for multiple locks on a single power supply.
  - d. Low holding current – maximum 0.01 amps to produce minimal heat, eliminate "hot levers" in electrically locked applications, and to provide reliable operation in wood doors that provide minimal ventilation and air flow.
  - e. Connections – provide quick-connect Molex system standard.
8. Lever Trim: Solid brass, bronze, or stainless steel, cast or forged in design specified, with wrought roses and external lever spring cages. Provide thru-bolted levers with 2-piece spindles.
  - a. Lever Design: 03A

## 2.7 EXIT DEVICES

### A. Manufacturers and Products:

1. Scheduled Manufacturer and Product:
  - a. Von Duprin 98/35A series

2. Acceptable Manufacturers and Products:
  - a. No Substitute
  
- B. Requirements:
  1. Provide exit devices tested to ANSI/BHMA A156.3 Grade 1 and UL listed for Panic Exit or Fire Exit Hardware.
  2. Cylinders: Refer to "KEYING" article, herein.
  3. Provide smooth touchpad type exit devices, fabricated of brass, bronze, stainless steel, or aluminum, plated to standard architectural finishes to match balance of door hardware.
  4. Touchpad must extend a minimum of one half of door width. No plastic inserts are allowed in touchpads.
  5. Provide exit devices with deadlatching feature for security and for future addition of alarm kits and/or other electrified requirements.
  6. Provide exit devices with weather resistant components that can withstand harsh conditions of various climates and corrosive cleaners used in outdoor pool environments.
  7. Provide flush end caps for exit devices.
  8. Provide exit devices with manufacturer's approved strikes.
  9. Provide exit devices cut to door width and height. Install exit devices at height recommended by exit device manufacturer, allowable by governing building codes, and approved by Architect.
  10. Mount mechanism case flush on face of doors or provide spacers to fill gaps behind devices. Where glass trim or molding projects off face of door, provide glass bead kits.
  11. Provide cylinder or hex-key dogging as specified at non fire-rated openings.
  12. Removable Mullions: 2 inches (51 mm) x 3 inches (76 mm) steel tube. Where scheduled as keyed removable mullion, provide type that can be removed by use of a keyed cylinder, which is self-locking when re-installed.
  13. Provide factory drilled weep holes for exit devices used in full exterior application, highly corrosive areas, and where noted in hardware sets.
  14. Provide electrified options as scheduled.
  15. Top latch mounting: double- or single-tab mount for steel doors, face mount for aluminum doors eliminating requirement of tabs, and double tab mount for wood doors.
  16. Provide exit devices with optional trim designs to match other lever and pull designs used on the project.
  17. CVC
    - a. Provide cable-actuated concealed vertical latch system in two-point for non-rated or fire rated wood doors up to a 90 minute rating and less bottom latch (LBL) configuration for non-rated or fire rated wood doors up to 20 minute rating. Vertical rods not permitted.
      - 1) Cable: Stainless steel with abrasive resistant coating. Conduit and core wire ends snap into latch and center slides without use of tools.
      - 2) Wood Door Prep: Maximum 1 inch x 1.1875 inch x 3.875 inches top latch pocket and 1 inch x 1.1875 inch x 5 inches bottom latch pocket which does not require the use of a metal wrap or edge for non-rated or fire rated wood doors up to a 45 minute rating.
      - 3) Latchbolts and Blocking Cams: Manufactured from sintered metal low carbon copper-infiltrated steel, with molybdenum disulfide low friction coating.
      - 4) Top Latchbolt: Minimum 0.38 inch (10 mm) and greater than 90-degree engagement with strike to prevent door and frame separation under high static load.
      - 5) Bottom Latchbolt: Minimum of 0.44-inch (11 mm) engagement with strike.
      - 6) Product Cycle Life: 1,000,000 cycles.
      - 7) Latch Operation: Top and bottom latch operate independently of each other. Top latch fully engages top strike even when bottom latch is compromised. Separate trigger mechanisms not permitted.
      - 8) Latch release does not require separate trigger mechanism.
      - 9) Cable and latching system characteristics:
        - a) Installed independently of exit device installation, and capable of functioning on door prior to device and trim installation.
        - b) Connected to exit device at single point in steel and aluminum doors, and two points for top and bottom latches in wood doors.
        - c) Bottom latch height adjusted, from single point for steel and aluminum doors and two points for wood doors, after system is installed and connected to exit device, while door is hanging.

- d) Bottom latch position altered up and down minimum of 2 inches (51 mm) in steel and aluminum doors without additional adjustment. Bottom latch deadlocks in every adjustment position in wood doors.
- e) Top and bottom latches in steel and aluminum doors and top latch in wood doors may be removed while door is hanging.

## 2.8 POWER SUPPLIES

- A. Manufacturers and Products:
  - 1. Scheduled Manufacturer and Product:
    - a. Schlage/Von Duprin PS900 Series
  - 2. Acceptable Manufacturers and Products:
    - a. Security Door Controls 600 series
- B. Requirements:
  - 1. Provide power supplies approved by manufacturer of supplied electrified hardware.
  - 2. Provide appropriate quantity of power supplies necessary for proper operation of electrified locking components as recommended by manufacturer of electrified locking components with consideration for each electrified component using power supply, location of power supply, and approved wiring diagrams. Locate power supplies as directed by Architect.
  - 3. Provide regulated and filtered 24 VDC power supply, and UL class 2 listed.
  - 4. Provide power supplies with the following features:
    - a. 12/24 VDC Output, field selectable.
    - b. Class 2 Rated power limited output.
    - c. Universal 120-240 VAC input.
    - d. Low voltage DC, regulated and filtered.
    - e. Polarized connector for distribution boards.
    - f. Fused primary input.
    - g. AC input and DC output monitoring circuit w/LED indicators.
    - h. Cover mounted AC Input indication.
    - i. Tested and certified to meet UL294.
    - j. NEMA 1 enclosure.
    - k. Hinged cover w/lock down screws.
    - l. High voltage protective cover.

## 2.9 CYLINDERS

- A. Manufacturers:
  - 1. Scheduled Manufacturer and Product:
    - a. Match Existing Cores/Cylinders
  - 2. Acceptable Manufacturers and Products:
    - a. No Substitute
- B. Requirements:
  - 1. Provide cylinders/cores to match Owner's existing key system, compliant with ANSI/BHMA A156.5; latest revision; cylinder face finished to match lockset, manufacturer's series as indicated. Refer to "KEYING" article, herein.

## 2.10 KEYING

- A. Scheduled System:
  - 1. Existing system:
    - a. Provide cylinders/cores keyed into Owner's existing factory registered keying system. Comply with guidelines in ANSI/BHMA A156.28, incorporating decisions made at keying conference.
- B. Requirements:
  - 1. Construction Keying:
    - a. Temporary Construction Cylinder Keying.
      - 1) Provide construction cores that permit voiding construction keys without cylinder removal, furnished in accordance with the following requirements.
        - a) Split Key or Lost Ball Construction Keying System.
        - b) 3 construction control keys, and extractor tools or keys as required to void construction keying.
        - c) 12 construction change (day) keys.
      - 2) Owner or Owner's Representative will void operation of temporary construction keys.
    - b. Replaceable Construction Cores.
      - 1) Provide temporary construction cores replaceable by permanent cores, furnished in accordance with the following requirements.
        - a) 3 construction control keys
        - b) 12 construction change (day) keys.
      - 2) Owner or Owner's Representative will replace temporary construction cores with permanent cores.
  - 2. Permanent Keying:
    - a. Provide permanent cylinders/cores keyed by the manufacturer according to the following key system.
      - 1) Master Keying system as directed by the Owner.
    - b. Forward bitting list and keys separately from cylinders, by means as directed by Owner. Failure to comply with forwarding requirements will be cause for replacement of cylinders/cores involved at no additional cost to Owner.
    - c. Provide keys with the following features:
      - 1) Material: Nickel silver; minimum thickness of .107-inch (2.3mm)
      - 2) Patent Protection: Keys and blanks protected by one or more utility patent(s).
      - 3) Geographically Exclusive: Where High Security or Security cylinders/cores are indicated, provide nationwide, geographically exclusive key system complying with the following restrictions.
    - d. Identification:
      - 1) Mark permanent cylinders/cores and keys with applicable blind code for identification. Do not provide blind code marks with actual key cuts.
      - 2) Identification stamping provisions must be approved by the Architect and Owner.
      - 3) Stamp cylinders/cores and keys with Owner's unique key system facility code as established by the manufacturer; key symbol and embossed or stamped with "DO NOT DUPLICATE" along with the "PATENTED" or patent number to enforce the patent protection.
      - 4) Failure to comply with stamping requirements will be cause for replacement of keys involved at no additional cost to Owner.
      - 5) Forward permanent cylinders/cores to Owner, separately from keys, by means as directed by Owner.
    - e. Quantity: Furnish in the following quantities.
      - 1) Permanent Control Keys: 3.
      - 2) Master Keys: 6.
      - 3) Change (Day) Keys: 3 per cylinder/core that is keyed differently.
      - 4) Key Blanks: Quantity as determined in the keying meeting.

## 2.11 DOOR CLOSERS

- A. Manufacturers and Products:
  - 1. Scheduled Manufacturer and Product:
    - a. LCN 4010/4110/4020 series
  - 2. Acceptable Manufacturers and Products:
    - a. No Substitute
- B. Requirements:
  - 1. Provide door closers conforming to ANSI/BHMA A156.4 Grade 1 requirements by BHMA certified independent testing laboratory. Certify surface mounted mechanical closers to meet fifteen million (15,000,000) full load cycles. ISO 9000 certify closers. Stamp units with date of manufacture code.
  - 2. Provide door closers with fully hydraulic, full rack and pinion action with high strength cast iron cylinder, and full complement bearings at shaft.
  - 3. Cylinder Body: 1-1/2-inch (38 mm) diameter with 11/16-inch (17 mm) diameter double heat-treated pinion journal.
  - 4. Hydraulic Fluid: Fireproof, passing requirements of UL10C, and requiring no seasonal closer adjustment for temperatures ranging from 120 degrees F to -30 degrees F.
  - 5. Spring Power: Continuously adjustable over full range of closer sizes, and providing reduced opening force as required by accessibility codes and standards.
  - 6. Hydraulic Regulation: By tamper-proof, non-critical valves, with separate adjustment for latch speed, general speed, and backcheck.
  - 7. Provide closers with solid forged steel main arms and factory assembled heavy-duty forged forearms for parallel arm closers. When closers are parallel arm mounted, provide closers which mount within 6-inch (152 mm) top rail without use of mounting plate so that closer is not visible through vision panel from pull side.
  - 8. Pressure Relief Valve (PRV) Technology: Not permitted.
  - 9. Finish for Closer Cylinders, Arms, Adapter Plates, and Metal Covers: Powder coating finish which has been certified to exceed 100 hours salt spray testing as described in ANSI/BHMA Standard A156.4 and ASTM B117, or has special rust inhibitor (SRI).
  - 10. Provide special templates, drop plates, mounting brackets, or adapters for arms as required for details, overhead stops, and other door hardware items interfering with closer mounting.

## 2.12 DOOR TRIM

- A. Manufacturers:
  - 1. Scheduled Manufacturer:
    - a. Ives
  - 2. Acceptable Manufacturers:
    - a. Burns
    - b. Rockwood
- B. Requirements:
  - 1. Provide push plates, push bars, pull plates, pulls, and hands-free reversible door pulls with diameter and length as scheduled.

## 2.13 PROTECTION PLATES

- A. Manufacturers:
  - 1. Scheduled Manufacturer:
    - a. Ives
  - 2. Acceptable Manufacturers:
    - a. Burns
    - b. Rockwood

- B. Requirements:
  - 1. Provide protection plates with a minimum of 0.050 inch (1 mm) thick, beveled four edges as scheduled. Furnish with sheet metal or wood screws, finished to match plates.
  - 2. Sizes plates 2 inches (51 mm) less width of door on single doors, pairs of doors with a mullion, and doors with edge guards. Size plates 1 inch (25 mm) less width of door on pairs without a mullion or edge guards.
  - 3. At fire rated doors, provide protection plates over 16 inches high with UL label.

#### 2.14 OVERHEAD STOPS AND OVERHEAD STOP/HOLDERS

- A. Manufacturers:
  - 1. Scheduled Manufacturers:
    - a. Glynn-Johnson
  - 2. Acceptable Manufacturers:
    - a. Rixson
    - b. ABH
- B. Requirements:
  - 1. Provide overhead stop at any door where conditions do not allow for a wall stop or floor stop presents tripping hazard.

#### 2.15 DOOR STOPS AND HOLDERS

- A. Manufacturers:
  - 1. Scheduled Manufacturer:
    - a. Ives
  - 2. Acceptable Manufacturers:
    - a. Burns
    - b. Rockwood
- B. Provide door stops at each door leaf:
  - 1. Provide wall stops wherever possible. Provide concave type where lockset has a push button of thumbturn.
  - 2. Where a wall stop cannot be used, provide universal floor stops.
  - 3. Where wall or floor stop cannot be used, provide overhead stop.
  - 4. Provide roller bumper where doors open into each other and overhead stop cannot be used.

#### 2.16 THRESHOLDS, SEALS, DOOR SWEEPS, AUTOMATIC DOOR BOTTOMS, AND GASKETING

- A. Manufacturers:
  - 1. Scheduled Manufacturer:
    - a. Zero International
  - 2. Acceptable Manufacturers:
    - a. National Guard
    - b. Reese
- B. Requirements:
  - 1. Provide thresholds, weather-stripping, and gasketing systems as specified and per architectural details. Match finish of other items.
  - 2. Smoke- and Draft-Control Door Assemblies: Where smoke- and draft-control door assemblies are required, provide door hardware that meets requirements of assemblies tested according to UL 1784 and installed in compliance with NFPA 105.
  - 3. Provide door sweeps, seals, astragals, and auto door bottoms only of type where resilient or flexible seal strip is easily replaceable and readily available.
  - 4. Size thresholds 1/2 inch (13 mm) high by 5 inches (127 mm) wide by door width unless otherwise specified in the hardware sets or detailed in the drawings.



## 2.17 DOOR POSITION SWITCHES

- A. Manufacturers:
  - 1. Scheduled Manufacturer:
    - a. Schlage
  - 2. Acceptable Manufacturers:
    - a. Nascom
    - b. Security Door Controls
- B. Requirements:
  - 1. Provide recessed or surface mounted type door position switches as specified.
  - 2. Coordinate door and frame preparations with door and frame suppliers. If switches are being used with magnetic locking device, provide minimum of 4 inches (102 mm) between switch and magnetic locking device.

## 2.18 FINISHES

- A. Provide finishes as specified unless otherwise noted by architect/owner.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Prior to installation of hardware, examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire-rated door assembly construction, wall and floor construction, and other conditions affecting performance. Verify doors, frames, and walls have been properly reinforced for hardware installation.
- B. Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.
- C. Submit a list of deficiencies in writing and proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. 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.
  - 3. Interior Architectural Wood Flush Doors: ANSI/WDMA I.S. 1A.
  - 4. Installation Guide for Doors and Hardware: DHI TDH-007-20.
- B. Install door hardware in accordance with NFPA 80, NFPA 101 and provide post-install inspection, testing as specified in section 1.03.E unless otherwise required to comply with governing regulations.
- C. Install each hardware item in compliance with manufacturer's instructions and recommendations, using only fasteners provided by manufacturer.
- D. Do not install surface mounted items until finishes have been completed on substrate. Protect all installed hardware during painting.
- E. Set units level, plumb and true to line and location. Adjust and reinforce attachment substrate as necessary for proper installation and operation.
- F. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.

- G. Install operating parts so they move freely and smoothly without binding, sticking, or excessive clearance.
- H. Hinges: Install types and in quantities indicated in door hardware schedule but not fewer than quantity recommended by manufacturer for application indicated.
- I. Lock Cylinders:
  - 1. Install construction cores to secure building and areas during construction period.
  - 2. Replace construction cores with permanent cores as indicated in keying section.
  - 3. Furnish permanent cores to Owner for installation.
- J. Wiring: Coordinate with Division 26, ELECTRICAL and Division 28 ELECTRONIC SAFETY AND SECURITY sections for:
  - 1. Conduit, junction boxes and wire pulls.
  - 2. Connections to and from power supplies to electrified hardware.
  - 3. Connections to fire/smoke alarm system and smoke evacuation system.
  - 4. Connection of wire to door position switches and wire runs to central room or area, as directed by Architect.
  - 5. Connections to panel interface modules, controllers, and gateways.
  - 6. Testing and labeling wires with Architect's opening number.
- K. Continuous Hinges: Re-locate the door and frame fire rating labels where they will remain visible so that the hinge does not cover the label once installed.
- L. Door Closers & Auto Operators: Mount closers/operators on room side of corridor doors, inside of exterior doors, and stair side of stairway doors from corridors. Mount closers/operators so they are not visible in corridors, lobbies and other public spaces unless approved by Architect.
- M. Overhead Stops/Holders: Mount overhead stops/holders on room side of corridor doors, inside of exterior doors, and stair side of stairway doors.
- N. Power Supplies: Locate power supplies as indicated or, if not indicated, above accessible ceilings or in equipment room, or alternate location as directed by Architect.
- O. Thresholds: Set thresholds in full bed of sealant complying with requirements specified in Division 07 Section "Joint Sealants."
- P. 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 may impede traffic or present tripping hazard.
- Q. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.
- R. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.
- S. Door Bottoms and Sweeps: Apply to bottom of door, forming seal with threshold when door is closed.

### 3.3 ADJUSTING

- A. Initial Adjustment: 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.
  - 1. Door Closers: Adjust sweep period to comply with accessibility requirements and requirements of authorities having jurisdiction.
- B. Occupancy Adjustment: Approximately three to six months after date of Substantial Completion, examine and readjust each item of door hardware, including adjusting operating forces, as necessary to ensure function of doors and door hardware.

### 3.4 CLEANING AND PROTECTION

- A. Clean adjacent surfaces soiled by door hardware installation.
- B. Clean operating items per manufacturer's instructions to restore proper function and finish.
- C. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of Substantial Completion.

### 3.5 DOOR HARDWARE SCHEDULE

- A. The intent of the hardware specification is to specify the hardware for interior and exterior doors, and to establish a type, continuity, and standard of quality. However, it is the door hardware supplier's responsibility to thoroughly review existing conditions, schedules, specifications, drawings, and other Contract Documents to verify the suitability of the hardware specified.
- B. Discrepancies, conflicting hardware, and missing items are to be brought to the attention of the architect with corrections made prior to the bidding process. Omitted items not included in a hardware set should be scheduled with the appropriate additional hardware required for proper application.
- C. Hardware items are referenced in the following hardware schedule. Refer to the above specifications for special features, options, cylinders/keying, and other requirements.

D. Hardware Sets:

Hardware Group No. 01

For use on Door #(s):  
101

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	CONTINUOUS HINGE	SL11HD/SL14HD	BK	SEL
1	EA	PANIC HARDWARE	CD-98-NL-OP-110MD	711	VON
2	EA	PERMANENT CORE	7-PIN; KEY TO EXISTING SYSTEM		BES
1	EA	RIM CYL. HOUSING	1E72 - TAILPIECE & BLOCKING RING AS REQUIRED	BK	BES
1	EA	MORT. CYL. HOUSING	1E74 (DOGGING) - CAM & BLOCKING RING AS REQUIRED	BK	BES
1	EA	90 DEG OFFSET PULL	8190EZHD 12" O	BLK	IVE
1	EA	SURFACE CLOSER	4111 SCUSH MC	693	LCN
1	EA	MOUNTING PLATE	4110-XX (AS REQ'D)	693	LCN
1	EA	CUSH SHOE SUPPORT	4110-30 (AS REQ'D)	693	LCN
1	EA	BLADE STOP SPACER	4110-61 (AS REQ'D)	693	LCN
1	EA	WEATHERSTRIPPING/GASKETING	BY DOOR/FRAME MANUFACTURER		B/O
1	EA	DOOR SWEEP	39BK	BK	ZER
1	EA	THRESHOLD	545A-E-V3-226	A	ZER

Hardware Group No. 02

For use on Door #(s):  
200A

Provide each SGL door(s) with the following:



QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	CONTINUOUS HINGE	SL11HD/SL14HD	BK	SEL
1	EA	PANIC HARDWARE	LD-98-EO	711	VON
1	EA	SURFACE CLOSER	4111 SCUSH MC ST-1586	693	LCN
1	EA	MOUNTING PLATE	4110-XX (AS REQ'D)	693	LCN
1	EA	CUSH SHOE SUPPORT	4110-30 (AS REQ'D)	693	LCN
1	EA	KICK PLATE	8400 10" X 1 1/2" LDW B-CS	BLK	IVE
1	EA	RAIN DRIP	142BK	BK	ZER
1	EA	GASKETING	429BK	BK	ZER
1	EA	DOOR SWEEP	39BK	BK	ZER
1	EA	THRESHOLD	545A-E-V3-226	A	ZER

Hardware Group No. 03

For use on Door #(s):

104	105	106	107	108	151
152	153	154	155	156	157
158	159	160	161	162	203
204	205	206	207	208	209
210	211	214			

Provide each SGL door(s) with the following:



QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
1	EA	CONTINUOUS HINGE	SL11HD/SL14HD		BK	SEL
1	EA	OFFICE/ENTRY LOCK	L9050BDC 03A 09-544		622	SCH
1	EA	PERMANENT CORE	7-PIN; KEY TO EXISTING SYSTEM			BES
1	EA	WALL STOP	WS443/447		BLK	IVE

Hardware Group No. 04

For use on Door #(s):

213

Provide each SGL door(s) with the following:



QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
1	EA	CONTINUOUS HINGE	SL11HD/SL14HD		BK	SEL
1	EA	OFFICE/ENTRY LOCK	L9050BDC 03A 09-544		622	SCH
1	EA	PERMANENT CORE	7-PIN; KEY TO EXISTING SYSTEM			BES
1	EA	OH STOP	100S		BLK	GLY

Hardware Group No. 05

For use on Door #(s):

102	163	171	202
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Provide each SGL door(s) with the following:



QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
1	EA	CONTINUOUS HINGE	SL11HD/SL14HD		BK	SEL
1	EA	PASSAGE SET	L9010 03A		622	SCH
1	EA	WALL STOP	WS443/447		BLK	IVE

Hardware Group No. 06

For use on Door #(s):

174







Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
1	EA	CONTINUOUS HINGE	SL11HD/SL14HD		BK	SEL
1	EA	PASSAGE SET	L9010 03A		622	SCH
1	EA	OH STOP	100S		BLK	GLY

Hardware Group No. 07

For use on Door #(s):  
167 168






Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1HW 4.5 X 4.5		FBLK/6 31	IVE
1	EA	PUSH PLATE	8200 6" X 16"		BLK	IVE
1	EA	PULL PLATE	8302 10" 4" X 16"		BLK	IVE
1	EA	SURFACE CLOSER	4111 EDA MC		693	LCN
1	EA	KICK PLATE	8400 10" X 1 1/2" LDW B-CS		BLK	IVE
1	EA	WALL STOP	WS443/447		BLK	IVE

Hardware Group No. 08

For use on Door #(s):  
103A 164 165 212







Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1HW 4.5 X 4.5		FBLK/6 31	IVE
1	EA	STOREROOM LOCK	L9080BDC 03A		622	SCH
1	EA	PERMANENT CORE	7-PIN; KEY TO EXISTING SYSTEM			BES
1	EA	SURFACE CLOSER	4011 MC		693	LCN
1	EA	KICK PLATE	8400 10" X 1 1/2" LDW B-CS		BLK	IVE
1	EA	WALL STOP	WS443/447		BLK	IVE

Hardware Group No. 09

For use on Door #(s):  
169


Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1HW 4.5 X 4.5		FBLK/6 31	IVE
1	EA	OFFICE W/SIM RETRACT W/ OUTSIDE INDICATOR	L9056BDC 03A 09-544 OS-OCC		622	SCH
1	EA	PERMANENT CORE	7-PIN; KEY TO EXISTING SYSTEM			BES
1	EA	SURFACE CLOSER	4011 MC		693	LCN
1	EA	KICK PLATE	8400 10" X 1 1/2" LDW B-CS		BLK	IVE
1	EA	WALL STOP	WS443/447		BLK	IVE
1	EA	GASKETING	488SBK		BK	ZER

Hardware Group No. 10

For use on Door #(s):  
172

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	CONTINUOUS HINGE	SL11HD/SL14HD VD-EPT	BK	SEL
1	EA	POWER TRANSFER	PROVIDED BY SECURITY CONTRACTOR	 ⚡	
1	EA	ELEC PANIC HARDWARE	PROVIDED BY SECURITY CONTRACTOR	 ⚡	
1	EA	PERMANENT CORE	PROVIDED BY SECURITY CONTRACTOR		
1	EA	RIM CYL. HOUSING	PROVIDED BY SECURITY CONTRACTOR		
1	EA	90 DEG OFFSET PULL	8190EZHD 12" O	BLK	IVE
1	EA	SURFACE CLOSER	4111 EDA MC	693	LCN
1	EA	MOUNTING PLATE	4110-XX (AS REQ'D)	693	LCN
1	EA	BLADE STOP SPACER	4110-61 (AS REQ'D)	693	LCN
1	EA	WALL STOP	WS443/447	BLK	IVE
1	EA	WEATHERSTRIPPING/GASKETING	BY DOOR/FRAME MANUFACTURER		B/O
1	EA	CARD READER	PROVIDED BY SECURITY CONTRACTOR	⚡	B/O
1	EA	DOOR CONTACT	PROVIDED BY SECURITY CONTRACTOR	 ⚡	

DESCRIPTION OF OPERATION:

1. NORMALLY SECURE, ACCESS CONTROLLED OPENING.
2. OPENING IS CONTROLLED (LOCKED/UNLOCKED) BY HEAD END ACCESS CONTROL SYSTEM, AND CAN BE PROGRAMMED TO LOCK/UNLOCK AT OWNERS DISCRETION.
3. ACCESS BY PRESENTING A VALID CREDENTIAL TO THE CARD READER, OR WHEN OPENING IS UNLOCKED BY HEAD END ACCESS CONTROL SYSTEM, OR BY MECHANICAL KEY.
4. EXIT DEVICE TO HAVE ELECTRIC LATCH RETRACTION AND REQUEST TO EXIT SWITCHES (RX).
5. FREE EGRESS MAINTAINED AT ALL TIMES BY DEPRESSING EXIT DEVICE PUSH BAR.

COORDINATE SYSTEM OPERATION AND COMPONENT LOCATIONS WITH THE OWNER, THE ARCHITECT AND ALL RELATED TRADES.

Hardware Group No. 11

For use on Door #(s):

101A 175C

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
2	EA	CONTINUOUS HINGE	SL11HD/SL14HD VD-EPT	BK	SEL
2	EA	POWER TRANSFER	PROVIDED BY SECURITY CONTRACTOR	 	
1	EA	ELEC PANIC HARDWARE	PROVIDED BY SECURITY CONTRACTOR	 	
1	EA	ELEC PANIC HARDWARE	PROVIDED BY SECURITY CONTRACTOR	 	
1	EA	PERMANENT CORE	PROVIDED BY SECURITY CONTRACTOR		
1	EA	RIM CYL. HOUSING	PROVIDED BY SECURITY CONTRACTOR		
2	EA	90 DEG OFFSET PULL	8190EZHD 12" O	 BLK	IVE
2	EA	SURFACE CLOSER	4111 EDA MC	 693	LCN
2	EA	MOUNTING PLATE	4110-XX (AS REQ'D)	693	LCN
2	EA	BLADE STOP SPACER	4110-61 (AS REQ'D)	693	LCN
2	EA	WALL STOP	WS443/447	 BLK	IVE
1	EA	WEATHERSTRIPPING/GASKETING	BY DOOR/FRAME MANUFACTURER		B/O
1	EA	CARD READER	PROVIDED BY SECURITY CONTRACTOR		B/O
2	EA	DOOR CONTACT	PROVIDED BY SECURITY CONTRACTOR	 	

DESCRIPTION OF OPERATION:

1. NORMALLY SECURE, ACCESS CONTROLLED OPENING.
2. OPENING IS CONTROLLED (LOCKED/UNLOCKED) BY HEAD END ACCESS CONTROL SYSTEM, AND CAN BE PROGRAMMED TO LOCK/UNLOCK AT OWNERS DISCRETION.
3. ACCESS BY PRESENTING A VALID CREDENTIAL TO THE CARD READER, OR WHEN OPENING IS UNLOCKED BY HEAD END ACCESS CONTROL SYSTEM, OR BY MECHANICAL KEY.
4. EXIT DEVICE TO HAVE ELECTRIC LATCH RETRACTION AND REQUEST TO EXIT SWITCHES (RX).
5. FREE EGRESS MAINTAINED AT ALL TIMES BY DEPRESSING EXIT DEVICE PUSH BAR.

COORDINATE SYSTEM OPERATION AND COMPONENT LOCATIONS WITH THE OWNER, THE ARCHITECT AND ALL RELATED TRADES.



Hardware Group No. 12

For use on Door #(s):  
103

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
6	EA	HINGE	5BB1HW 4.5 X 4.5 NRP		FBLK/6 31	IVE
2	EA	POWER TRANSFER	PROVIDED BY SECURITY CONTRACTOR		⚡	
1	EA	FIRE RATED REMOVABLE MULLION	KR9954 STAB			
1	EA	ELEC FIRE EXIT HARDWARE	PROVIDED BY SECURITY CONTRACTOR		⚡	
1	EA	ELEC FIRE EXIT HARDWARE	PROVIDED BY SECURITY CONTRACTOR		⚡	
2	EA	PERMANENT CORE	PROVIDED BY SECURITY CONTRACTOR			
1	EA	RIM CYL. HOUSING	PROVIDED BY SECURITY CONTRACTOR			
1	EA	MORT. CYL. HOUSING	1E74 (MULLION) - CAM & BLOCKING RING AS REQUIRED		BK	BES
2	EA	SURFACE CLOSER	4111 EDA MC		693	LCN
2	EA	KICK PLATE	8400 10" X 1 1/2" LDW B-CS		BLK	IVE
2	EA	WALL STOP	WS443/447		BLK	IVE
1	EA	GASKETING	488SBK		BK	ZER
1	EA	MULLION SEAL	8780N		BK	ZER
1	EA	CARD READER	PROVIDED BY SECURITY CONTRACTOR		⚡	B/O
2	EA	DOOR CONTACT	PROVIDED BY SECURITY CONTRACTOR		⚡	

DESCRIPTION OF OPERATION:







1. NORMALLY SECURE, ACCESS CONTROLLED OPENING.
2. OPENING IS CONTROLLED (LOCKED/UNLOCKED) BY HEAD END ACCESS CONTROL SYSTEM, AND CAN BE PROGRAMMED TO LOCK/UNLOCK AT OWNERS DISCRETION.
3. ACCESS BY PRESENTING A VALID CREDENTIAL TO THE CARD READER, OR WHEN OPENING IS UNLOCKED BY HEAD END ACCESS CONTROL SYSTEM, OR BY MECHANICAL KEY.
4. EXIT DEVICE TO HAVE ELECTRIC LATCH RETRACTION AND REQUEST TO EXIT SWITCHES (RX).
5. FREE EGRESS MAINTAINED AT ALL TIMES BY DEPRESSING EXIT DEVICE PUSH BAR.

COORDINATE SYSTEM OPERATION AND COMPONENT LOCATIONS WITH THE OWNER, THE ARCHITECT AND ALL RELATED TRADES.

Hardware Group No. 13

For use on Door #(s):  
175B








Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
2	EA	CONTINUOUS HINGE	SL11HD/SL14HD		BK	SEL
1	EA	REMOVABLE MULLION	KR4954 STAB		622	VON
1	EA	PANIC HARDWARE	CD-98-EO		711	VON
1	EA	PANIC HARDWARE	CD-98-NL-OP-110MD		711	VON
2	EA	PERMANENT CORE	7-PIN; KEY TO EXISTING SYSTEM			BES
1	EA	RIM CYL. HOUSING	1E72 - TAILPIECE & BLOCKING RING AS REQUIRED		BK	BES
1	EA	MORT. CYL. HOUSING	1E74 (MULLION) - CAM & BLOCKING RING AS REQUIRED		BK	BES
2	EA	90 DEG OFFSET PULL	8190EZHD 12" O		BLK	IVE
2	EA	SURFACE CLOSER	4111 EDA MC		693	LCN
2	EA	MOUNTING PLATE	4110-XX (AS REQ'D)		693	LCN
2	EA	BLADE STOP SPACER	4110-61 (AS REQ'D)		693	LCN
2	EA	WALL STOP	WS443/447		BLK	IVE
1	EA	WEATHERSTRIPPING/GASKETING	BY DOOR/FRAME MANUFACTURER			B/O

Hardware Group No. 14

For use on Door #(s):  
215

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
1	EA	CONTINUOUS HINGE	SL11HD/SL14HD		BK	SEL
1	EA	POWER TRANSFER	PROVIDED BY SECURITY CONTRACTOR	 ⚡		
1	EA	EU MORTISE LOCK	PROVIDED BY SECURITY CONTRACTOR	 ⚡		
1	EA	PERMANENT CORE	PROVIDED BY SECURITY CONTRACTOR			
1	EA	OH STOP	100S		BLK	GLY
1	EA	SURFACE CLOSER	4011 MC ST-1544		693	LCN
1	EA	MOUNTING PLATE	4020-18		693	LCN
1	EA	KICK PLATE	8400 10" X 1 1/2" LDW B-CS		BLK	IVE
1	EA	CARD READER	PROVIDED BY SECURITY CONTRACTOR	⚡		
1	EA	DOOR CONTACT	PROVIDED BY SECURITY CONTRACTOR	 ⚡		S

DESCRIPTION OF OPERATION:






1. NORMALLY SECURE, ACCESS CONTROLLED OPENING.
2. OPENING IS CONTROLLED (LOCKED/UNLOCKED) BY HEAD END ACCESS CONTROL SYSTEM, AND CAN BE PROGRAMMED TO LOCK/UNLOCK AT OWNERS DISCRETION.
3. ACCESS BY PRESENTING A VALID CREDENTIAL TO THE CARD READER, WHEN OPENING IS UNLOCKED BY HEAD END ACCESS CONTROL SYSTEM, OR BY MECHANICAL KEY.
4. LOCKSET TO HAVE REQUEST TO EXIT SWITCHES (RX).
5. FREE EGRESS MAINTAINED AT ALL TIMES BY DEPRESSING INSIDE LEVER.

COORDINATE SYSTEM OPERATION AND COMPONENT LOCATIONS WITH THE OWNER, THE ARCHITECT AND ALL RELATED TRADES.

Hardware Group No. 15

For use on Door #(s):  
200B

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
6	EA	HINGE	5BB1HW 4.5 X 4.5 NRP		FBLK/6 31	IVE
2	EA	MANUAL FLUSH BOLT	FB358/FB458 (AS REQ'D)		BLK	IVE
1	EA	DUST PROOF STRIKE	DP2		BLK	IVE
1	EA	STOREROOM LOCK	L9080BDC 03A		622	SCH
1	EA	PERMANENT CORE	7-PIN; KEY TO EXISTING SYSTEM			BES
2	EA	OH STOP	100S		BLK	GLY

END OF SECTION 08 71 00

## SECTION 08 80 00 - GLAZING

### PART 1 GENERAL

#### 1.1 SECTION INCLUDES

- A. Insulating glass units.
- B. Glazing units.
- C. Glazing compounds.

#### 1.2 SUBMITTALS

- A. Product Data on Glazing Types: Provide structural, physical and environmental characteristics, size limitations, special handling and installation requirements.
- B. Product Data on Glazing Compounds and Accessories: Provide chemical, functional, and environmental characteristics, limitations, special application requirements, and identify available colors.
- C. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

#### 1.3 QUALITY ASSURANCE

- A. Perform Work in accordance with GANA (GM), GANA (SM), GANA (LGRM), and IGMA TM-3000 for glazing installation methods. Maintain one copy on site.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years of documented experience.
  - 1. Provide certified glass products through ANSI accredited certifications that include plant audits and independent laboratory performance testing.
    - a. Insulating Glass Certification Council (IGCC).
    - b. Safety Glazing Certification Council (SGCC).
- C. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years documented experience.

#### 1.4 FIELD CONDITIONS

- A. Do not install glazing when ambient temperature is less than 40 degrees F.
- B. Maintain minimum ambient temperature before, during and 24 hours after installation of glazing compounds.

#### 1.5 WARRANTY

- A. Insulating Glass Units: Provide a five (5) year manufacturer warranty to include coverage for seal failure, interpane dusting or misting, including providing products to replace failed units.

- B. Heat Soaked Tempered Glass: Provide a five (5) year manufacturer warranty to include coverage for spontaneous breakage of fully tempered glass caused by nickel sulfide (NiS) inclusions.

## PART 2 PRODUCTS

### 2.1 MANUFACTURERS

#### A. Glass Fabricators:

1. GGI - General Glass International: [www.generalglass.com/#sle](http://www.generalglass.com/#sle).
2. JE Berkowitz, LP: [www.jeberkowitz.com/#sle](http://www.jeberkowitz.com/#sle).
3. Standard Bent Glass Corp: [www.standardbent.com/#sle](http://www.standardbent.com/#sle).
4. Thompson I.G., LLC: [www.thompsonig.com/#sle](http://www.thompsonig.com/#sle).
5. Trulite Glass & Aluminum Solutions, LLC: [www.trulite.com/#sle](http://www.trulite.com/#sle).
6. Viracon, Inc: [www.viracon.com/#sle](http://www.viracon.com/#sle).

#### B. Float Glass Manufacturers:

1. AGC Glass North America, Inc: [www.agcglass.com/#sle](http://www.agcglass.com/#sle).
2. Cardinal Glass Industries: [www.cardinalcorp.com/#sle](http://www.cardinalcorp.com/#sle).
3. Guardian Glass, LLC: [www.guardianglass.com/#sle](http://www.guardianglass.com/#sle).
4. Pilkington North America Inc: [www.pilkington.com/na/#sle](http://www.pilkington.com/na/#sle).
5. Vitro Architectural Glass (formerly PPG Glass): [www.vitroglazings.com/#sle](http://www.vitroglazings.com/#sle).

### 2.2 PERFORMANCE REQUIREMENTS - EXTERIOR GLAZING ASSEMBLIES

- A. Provide type and thickness of exterior glazing assemblies to support assembly dead loads, and to withstand live loads caused by positive and negative wind pressure acting normal to plane of glass.
  1. Design Pressure: Calculated in accordance with ASCE 7.
  2. Comply with ASTM E1300 for design load resistance of glass type, thickness, dimensions, and maximum lateral deflection of supported glass.
  3. Provide glass edge support system sufficiently stiff to limit the lateral deflection of supported glass edges to less than 1/175 of their lengths under specified design load.
  4. Glass thicknesses listed are minimum.
- B. Weather-Resistive Barrier Seals: Provide completed assemblies that maintain continuity of building enclosure water-resistive barrier, vapor retarder, and/or air barrier.
  1. To utilize inner pane of multiple pane insulating glass units for continuity of vapor retarder and/or air barrier seal.
  2. To maintain a continuous vapor retarder and/or air barrier throughout glazed assembly from glass pane to heel bead of glazing sealant.
- C. Thermal and Optical Performance: Provide exterior glazing products with performance properties as indicated. Performance properties are in accordance with manufacturer's published data as determined with the following procedures and/or test methods:
  1. Center of Glass U-Value: Comply with NFRC 100 using Lawrence Berkeley National Laboratory (LBNL) WINDOW 6.3 computer program.
  2. Center of Glass Solar Heat Gain Coefficient (SHGC): Comply with NFRC 200 using Lawrence Berkeley National Laboratory (LBNL) WINDOW 6.3 computer program.
  3. Solar Optical Properties: Comply with NFRC 300 test method.

### 2.3 GLASS MATERIALS

- A. Float Glass: Provide float glass based glazing unless otherwise indicated.
  1. Kind HS - Heat-Strengthened Type: Complies with ASTM C1048.
  2. Kind FT - Fully Tempered Type: Complies with ASTM C1048.

3. Fully Tempered Safety Glass: Complies with ANSI Z97.1 or 16 CFR 1201 criteria for safety glazing used in hazardous locations.
4. Heat-Soak Testing (HST): Provide HST of fully tempered glass used on point-supported, high-risk, or other demanding applications of project, to reduce risks of spontaneous breakage due to nickel sulfide (NiS) induced fractures in accordance with industry established testing requirements.

## 2.4 INSULATING GLASS UNITS

### A. Manufacturers:

1. Glass: Any of the manufacturers specified for float glass.
2. AGC Glass North America, Inc: [www.agcglass.com/#sle](http://www.agcglass.com/#sle).
3. Cardinal Glass Industries: [www.cardinalcorp.com/#sle](http://www.cardinalcorp.com/#sle).
4. Guardian Glass, LLC: [www.guardianglass.com/#sle](http://www.guardianglass.com/#sle).
5. Pilkington North America Inc: [www.pilkington.com/na/#sle](http://www.pilkington.com/na/#sle).Pilkington North America Inc:  
[www.pilkington.com/na/#sle](http://www.pilkington.com/na/#sle).
6. Viracon, Apogee Enterprises, Inc: [www.viracon.com/#sle](http://www.viracon.com/#sle).
7. Vitro Architectural Glass (formerly PPG Glass): [www.vitroglazings.com/#sle](http://www.vitroglazings.com/#sle).

### B. Insulating Glass Units: Types as indicated.

1. Durability: Certified by an independent testing agency to comply with ASTM E2190.
2. Coated Glass: Comply with requirements of ASTM C1376 for pyrolytic (hard-coat) or magnetic sputter vapor deposition (soft-coat) type coatings on flat glass; coated vision glass, Kind CV; coated overhead glass, Kind CO; or coated spandrel glass, Kind CS.
3. Metal-Edge Spacers: Aluminum, bent and soldered corners.
4. Spacer Color: Black.
5. Edge Seal:
  - a. Dual-Sealed System: Provide polyisobutylene sealant as primary seal applied between spacer and glass panes, and silicone, polysulfide, or polyurethane sealant as secondary seal applied around perimeter.
  - b. Color: Black.
6. Purge interpane space with dry air, hermetically sealed.

### C. Type IG-1 - Insulating Glass Units: Vision glass, double glazed.

1. Applications: Exterior glazing unless otherwise indicated.
2. Space between lites filled with argon.
3. Outboard Lite: Heat-strengthened float glass, 1/4 inch thick, minimum.
  - a. Tint: Clear.
4. Inboard Lite: Heat-strengthened float glass, 1/4 inch thick, minimum.
  - a. Tint: Clear.
5. Total Thickness: 1 inch.

## 2.5 GLAZING UNITS

### A. Type G-1 - Monolithic Safety Glazing: Non-fire-rated.

1. Applications:
  - a. Glazed lites in doors, except fire doors.
  - b. Glazed sidelights to doors, except in fire-rated walls and partitions.
  - c. Other locations required by applicable federal, state, and local codes and regulations.
  - d. Other locations indicated on drawings.
2. Glass Type: Fully tempered safety glass as specified.
3. Tint: Clear.
4. Thickness: 1/4 inch, nominal.

## 2.6 ACCESSORIES

- A. Setting Blocks: Silicone, with 80 to 90 Shore A durometer hardness; ASTM C864 Option II. Length of 0.1 inch for each square foot of glazing or minimum 4 inch by width of glazing rabbet space minus 1/16 inch

by height to suit glazing method and pane weight and area.

- B. Spacer Shims: Neoprene, 50 to 60 Shore A durometer hardness; ASTM C864 Option II. Minimum 3 inch long by one half the height of the glazing stop by thickness to suit application, self adhesive on one face.
- C. Glazing Splines: Resilient silicone extruded shape to suit glazing channel retaining slot; ASTM C864 Option II; color black.

### PART 3 EXECUTION

#### 3.1 VERIFICATION OF CONDITIONS

- A. Verify that openings for glazing are correctly sized and within tolerances, including those for size, squareness, and offsets at corners.
- B. Verify that the minimum required face and edge clearances are being provided.
- C. Verify that surfaces of glazing channels or recesses are clean, free of obstructions that may impede moisture movement, weeps are clear, and support framing is ready to receive glazing system.
- D. Verify that sealing between joints of glass framing members has been completed effectively.
- E. Proceed with glazing system installation only after unsatisfactory conditions have been corrected.

#### 3.2 PREPARATION

- A. Clean contact surfaces with appropriate solvent and wipe dry within maximum of 24 hours before glazing. Remove coatings that are not tightly bonded to substrates.
- B. Seal porous glazing channels or recesses with substrate compatible primer or sealer.
- C. Prime surfaces scheduled to receive sealant where required for proper sealant adhesion.

#### 3.3 INSTALLATION, GENERAL

- A. Install glazing in compliance with written instructions of glass, gaskets, and other glazing material manufacturers, unless more stringent requirements are indicated, including those in glazing referenced standards.
- B. Install glazing sealants in accordance with ASTM C1193, GANA (SM), and manufacturer's instructions.
- C. Do not exceed edge pressures around perimeter of glass lites as stipulated by glass manufacturer.
- D. Set glass lites of system with uniform pattern, draw, bow, and similar characteristics.
- E. Set glass lites in proper orientation so that coatings face exterior or interior as indicated.
- F. Prevent glass from contact with any contaminating substances that may be the result of construction operations such as, and not limited to the following; weld splatter, fire-safing, plastering, mortar droppings, etc.

### 3.4 INSTALLATION - DRY GLAZING METHOD (GASKET GLAZING)

- A. Application - Exterior and/or Interior Glazed: Set glazing infills from either the exterior or the interior of the building.
- B. Place setting blocks at 1/4 points with edge block no more than 6 inch from corners.
- C. Rest glazing on setting blocks and push against fixed stop with sufficient pressure on gasket to attain full contact.
- D. Install removable stops without displacing glazing gasket; exert pressure for full continuous contact.
- E. Install gaskets without joints, except at corners.
- F. Seal gasket corners.
- G. Install Pressure plates without displacing glazing gasket; except pressure for full continuous contact to product a weathertight seal without developing bending stresses in glass or over-compressing gaskets.

### 3.5 CLEANING

- A. Remove excess glazing materials from finish surfaces immediately after application using solvents or cleaners recommended by manufacturers.
- B. Remove nonpermanent labels immediately after glazing installation is complete.
- C. Clean glass and adjacent surfaces after sealants are fully cured.
- D. Clean glass on both exposed surfaces not more than 4 days prior to Date of Substantial Completion in accordance with glass manufacturer's written recommendations.

### 3.6 PROTECTION

- A. After installation, mark pane with an 'X' by using removable plastic tape or paste; do not mark heat absorbing or reflective glass units.
- B. Remove and replace glass that is damaged during construction period prior to Date of Substantial Completion.

END OF SECTION



## SECTION 09 05 61 - COMMON WORK RESULTS FOR FLOORING PREPARATION

### PART 1 GENERAL

#### 1.1 SECTION INCLUDES

- A. This section applies to floors identified in Contract Documents that are receiving the following types of floor coverings:
  - 1. Resilient tile and sheet.
  - 2. Carpet tile.
  - 3. Thin-set ceramic tile and stone tile.
- B. Removal of existing floor coverings.
- C. Preparation of new and existing concrete floor slabs for installation of floor coverings.
- D. Testing of concrete floor slabs for moisture and alkalinity (pH).
- E. Patching compound.
- F. Remedial floor coatings.
- G. Remedial floor sheet membrane.
- H. Preparation of new and existing wood-based floors and subfloors for installation of new floor coverings.

#### 1.2 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate scheduling of cleaning and testing, so that preliminary cleaning has been completed for at least 24 hours prior to testing.

#### 1.3 SUBMITTALS

- A. Visual Observation Report: For existing floor coverings to be removed.
- B. Floor Covering and Adhesive Manufacturers' Product Literature: For each specific combination of substrate, floor covering, and adhesive to be used; showing:
  - 1. Moisture and alkalinity (pH) limits and test methods.
  - 2. Manufacturer's required bond/compatibility test procedure.
- C. Testing Agency's Report:
  - 1. Description of areas tested; include floor plans and photographs if helpful.
  - 2. Summary of conditions encountered.
  - 3. Moisture and alkalinity (pH) test reports.
  - 4. Copies of specified test methods.
  - 5. Recommendations for remediation of unsatisfactory surfaces.
  - 6. Submit report to Architect.
  - 7. Submit report not more than two business days after conclusion of testing.
- D. Adhesive Bond and Compatibility Test Report.

E. Floor Moisture Testing Technician Certificate: International Concrete Repair Institute (ICRI) Concrete Slab Moisture Testing Technician- Grade I certificate.

F. Copy of RFCI (RWP).

#### 1.4 QUALITY ASSURANCE

- A. Moisture and alkalinity (pH) testing shall be performed by an independent testing agency employed and paid by Contractor.
- B. Contractor may perform adhesive and bond test with Contractor's own personnel or hire a testing agency.
- C. Testing Agency Qualifications: Independent testing agency experienced in the types of testing specified.
  - 1. Submit evidence of experience consisting of at least 3 test reports of the type required, with project Owner's project contact information.
- D. Contractor's Responsibility Relating to Independent Agency Testing:
  - 1. Provide access for and cooperate with testing agency.
  - 2. Confirm date of start of testing at least 10 days prior to actual start.
  - 3. Allow at least 4 business days on site for testing agency activities.
  - 4. Achieve and maintain specified ambient conditions.
  - 5. Notify Architect when specified ambient conditions have been achieved and when testing will start.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, handle, and protect products in accordance with manufacturer's instructions and recommendations.
- B. Deliver materials in manufacturer's packaging; include installation instructions.
- C. Keep materials from freezing.

#### 1.6 FIELD CONDITIONS

- A. Maintain ambient temperature in spaces where concrete testing is being performed, and for at least 48 hours prior to testing, at not less than 65 degrees F or more than 85 degrees F.
- B. Maintain relative humidity in spaces where concrete testing is being performed, and for at least 48 hours prior to testing, at not less than 40 percent and not more than 60 percent.

### PART 2 PRODUCTS

#### 2.1 MATERIALS

- A. Patching Compound: Floor covering manufacturer's recommended product, suitable for conditions, and compatible with adhesive and floor covering. In the absence of any recommendation from flooring manufacturer, provide a product with the following characteristics:
  - 1. Cementitious moisture-, mildew-, and alkali-resistant compound, compatible with floor, floor covering, and floor covering adhesive, and capable of being feathered to nothing at edges.
  - 2. Latex or polyvinyl acetate additions are permitted; gypsum content is prohibited.
  - 3. Compressive Strength: 3000 psi, minimum, after 28 days, when tested in accordance with ASTM C109/C109M or ASTM C472, whichever is appropriate.

- B. Alternate Flooring Adhesive: Floor covering manufacturer's recommended product, suitable for the moisture and pH conditions present; low-VOC. In the absence of any recommendation from flooring manufacturer, provide a product recommended by adhesive manufacturer as suitable for substrate and floor covering and for conditions present.
- C. Remedial Floor Coating: Single- or multi-layer coating or coating/overlay combination intended by its manufacturer to resist water vapor transmission to degree sufficient to meet flooring manufacturer's emission limits, resistant to the level of alkalinity (pH) found, and suitable for adhesion of flooring without further treatment.

### PART 3 EXECUTION

#### 3.1 CONCRETE SLAB PREPARATION

- A. Perform following operations in the order indicated:
  - 1. Existing concrete slabs (on-grade and elevated) with existing floor coverings:
    - a. Visual observation of existing floor covering, for adhesion, water damage, alkaline deposits, and other defects.
    - b. Removal of existing floor covering.
  - 2. Existing concrete slabs with coatings or penetrating sealers/hardeners/dustproofers:
    - a. Do not attempt to remove coating or penetrating material.
    - b. Do not abrade surface.
  - 3. Preliminary cleaning.
  - 4. Moisture vapor emission tests; 3 tests in the first 1000 square feet and one test in each additional 1000 square feet, unless otherwise indicated or required by flooring manufacturer.
  - 5. Internal relative humidity tests; in same locations as moisture vapor emission tests, unless otherwise indicated.
  - 6. Alkalinity (pH) tests; in same locations as moisture vapor emission tests, unless otherwise indicated.
  - 7. Specified remediation, if required.
  - 8. Patching, smoothing, and leveling, as required.
  - 9. Other preparation specified.
  - 10. Adhesive bond and compatibility test.
  - 11. Protection.

#### 3.2 REMOVAL OF EXISTING FLOOR COVERINGS

- A. Comply with local, State, and federal regulations and recommendations of RFCI Recommended Work Practices for Removal of Resilient Floor Coverings, as applicable to floor covering being removed.
- B. Dispose of removed materials in accordance with local, State, and federal regulations and as specified.

#### 3.3 PRELIMINARY CLEANING

- A. Clean floors of dust, solvents, paint, wax, oil, grease, asphalt, residual adhesive, adhesive removers, film-forming curing compounds, sealing compounds, alkaline salts, excessive laitance, mold, mildew, and other materials that might prevent adhesive bond.
- B. Do not use solvents or other chemicals for cleaning.

#### 3.4 MOISTURE VAPOR EMISSION TESTING

- A. Where the floor covering manufacturer's requirements conflict with either the referenced test method or this specification, comply with the manufacturer's requirements.

- B. Where this specification conflicts with the referenced test method, comply with the requirements of this section.
- C. Test in accordance with ASTM F1869 and as follows.
- D. Plastic sheet test and mat bond test may not be substituted for the specified ASTM test method, as those methods do not quantify the moisture content sufficiently.
- E. In the event that test values exceed floor covering manufacturer's limits, perform remediation as indicated. In the absence of manufacturer limits, perform remediation if test values exceed 3 pounds per 1000 square feet per 24 hours.
- F. Report: Report the information required by the test method.

### 3.5 INTERNAL RELATIVE HUMIDITY TESTING

- A. Where the floor covering manufacturer's requirements conflict with either the referenced test method or this specification, comply with the manufacturer's requirements.
- B. Where this specification conflicts with the referenced test method, comply with the requirements of this section.
- C. Test in accordance with ASTM F2170 Procedure A and as follows.
- D. Testing with electrical impedance or resistance apparatus may not be substituted for the specified ASTM test method, as the values determined are not comparable to the ASTM test values and do not quantify the moisture content sufficiently.
- E. In the event that test values exceed floor covering manufacturer's limits, perform remediation as indicated. In the absence of manufacturer limits, perform remediation if any test value exceeds 75 percent relative humidity.
- F. Report: Report the information required by the test method.

### 3.6 ALKALINITY TESTING

- A. Where the floor covering manufacturer's requirements conflict with either the referenced test method or this specification, comply with the manufacturer's requirements.
- B. The following procedure is the equivalent of that described in ASTM F710, repeated here for the Contractor's convenience.
  - 1. Use a wide range alkalinity (pH) test paper, its associated chart, and distilled or deionized water.
  - 2. Place several drops of water on a clean surface of concrete, forming a puddle approximately 1 inch in diameter. Allow the puddle to set for approximately 60 seconds, then dip the alkalinity (pH) test paper into the water, remove it, and compare immediately to chart to determine alkalinity (pH) reading.
  - 3. Use of a digital pH meter with probe is acceptable; follow meter manufacturer's instructions.
- C. In the event that test values exceed floor covering manufacturer's limits, perform remediation as indicated. In the absence of manufacturer limits, perform remediation if alkalinity (pH) test value is over 10.

### 3.7 PREPARATION

- A. See individual floor covering section(s) for additional requirements.
- B. Comply with recommendations of testing agency.
- C. Comply with requirements and recommendations of floor covering manufacturer.
- D. Fill and smooth surface cracks, grooves, depressions, control joints and other non-moving joints, and other irregularities with patching compound.
- E. Do not fill expansion joints, isolation joints, or other moving joints.

### 3.8 ADHESIVE BOND AND COMPATIBILITY TESTING

- A. Comply with requirements and recommendations of floor covering manufacturer.

### 3.9 APPLICATION OF REMEDIAL FLOOR COATING

- A. Comply with requirements and recommendations of coating manufacturer.

### 3.10 PROTECTION

- A. Cover prepared floors with building paper or other durable covering.

END OF SECTION

## SECTION 09 21 16 - GYPSUM BOARD ASSEMBLIES

### PART 1 GENERAL

#### 1.1 SECTION INCLUDES

- A. Performance criteria for gypsum board assemblies.
- B. Metal stud wall framing.
- C. Metal channel ceiling framing.
- D. Resilient sound isolation clips.
- E. Acoustic insulation.
- F. Gypsum sheathing.
- G. Cementitious backing board.
- H. Gypsum wallboard.
- I. Joint treatment and accessories.
- J. Plenum space sound control.
- K. Acoustic (sound-dampening) wall and ceiling board.

#### 1.2 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide manufacturer's data on partition head to structure connectors, showing compliance with requirements.

#### 1.3 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing gypsum board installation and finishing.
- B. Manufacturer Qualifications: Member of Steel Stud Manufacturers Association (SSMA):  
[www.ssma.com/#sle](http://www.ssma.com/#sle).

### PART 2 PRODUCTS

#### 2.1 GYPSUM BOARD ASSEMBLIES

- A. Provide completed assemblies complying with ASTM C840 and GA-216.
  - 1. See PART 3 for finishing requirements.
- B. Interior Partitions: Provide completed assemblies with the following characteristics:

1. Acoustic Attenuation: STC as indicated on drawings calculated in accordance with ASTM E413, based on tests conducted in accordance with ASTM E90.
- C. Shaft Walls at HVAC Shafts: Provide completed assemblies with the following characteristics:
  1. Air Pressure Within Shaft: Sustained loads of 5 lbf/sq ft with maximum mid-span deflection of L/240.
  2. Acoustic Attenuation: STC of 35-39 calculated in accordance with ASTM E413, based on tests conducted in accordance with ASTM E90.
- D. Fire-Resistance-Rated Assemblies: Provide completed assemblies with the following characteristics:
  1. Fire-Resistance-Rated Partitions: UL listed assembly No. 419; 1 hour rating.
  2. UL Assembly Numbers: Provide construction equivalent to that listed for the particular assembly in the current UL (FRD).

## 2.2 METAL FRAMING MATERIALS

- A. Manufacturers - Metal Framing, Connectors, and Accessories:
  1. ClarkDietrich: [www.clarkdietrich.com/#sle](http://www.clarkdietrich.com/#sle).
  2. Jaimes Industries: [www.jaimesind.com/#sle](http://www.jaimesind.com/#sle).
  3. Marino: [www.marinoware.com/#sle](http://www.marinoware.com/#sle).
  4. R-stud, LLC: [www.rstud.com/#sle](http://www.rstud.com/#sle).
  5. Phillips Manufacturing Co: [www.phillipsmfg.com/#sle](http://www.phillipsmfg.com/#sle).
  6. SCAFCO Corporation: [www.scafco.com/#sle](http://www.scafco.com/#sle).
  7. Steel Construction Systems: [www.steelconsystems.com/#sle](http://www.steelconsystems.com/#sle).
  8. Supreme Steel Framing System Association; Supreme Stud: [www.ssfsa.com/#sle](http://www.ssfsa.com/#sle).
- B. Non-structural Framing System Components: ASTM C645; galvanized sheet steel, of size and properties necessary to comply with ASTM C754 for the spacing indicated, with maximum deflection of wall framing of L/120 at 5 psf.
  1. Studs: C-shaped with knurled or embossed faces.
  2. Paired Studs for Sound-Rated Assemblies: Engineered single-piece assemblies comprised of paired studs coupled by sound isolators, designed to replace conventional side-by-side, parallel, double-wall partition framing.
    - a. Widths: As indicated on drawings.
    - b. Products:
      - 1) SCAFCO Corporation; SoundGuard Silent Steel Framing System: [www.scafco.com/#sle](http://www.scafco.com/#sle).
  3. Runners: U shaped, sized to match studs.
  4. Ceiling Channels: C-shaped.
  5. Furring Members: Hat-shaped sections, minimum depth of 7/8 inch.
    - a. Products:
      - 1) MBA Building Supplies; MBA Furring Channel: [www.mbastuds.com/#sle](http://www.mbastuds.com/#sle).
  6. Furring Members: U-shaped sections, minimum depth of 3/4 inch.
    - a. Products:
      - 1) MBA Building Supplies; MBA U-Channel: [www.mbastuds.com/#sle](http://www.mbastuds.com/#sle).
  7. Resilient Furring Channels: Single or double leg configuration; 1/2 inch channel depth.
    - a. Products:
      - 1) ClarkDietrich; RC Deluxe Resilient Channel: [www.clarkdietrich.com/#sle](http://www.clarkdietrich.com/#sle).
      - 2) Phillips Manufacturing Co; RC-2 Resilient Sound Channel: [www.phillipsmfg.com/#sle](http://www.phillipsmfg.com/#sle).
  8. Resilient Sound Isolation Clips: Steel resilient clips with molded rubber isolators, attaches to framing; improves noise isolation performance of wall and floor-ceiling assemblies.
    - a. Products:
      - 1) ClarkDietrich; Sound Clip (CDSC): [www.clarkdietrich.com/#sle](http://www.clarkdietrich.com/#sle).

- 2) Keene Building Products; Cylent Assurance Clip: [www.keenebuilding.com/#sle](http://www.keenebuilding.com/#sle).
  - 3) PAC International, Inc; RSIC-1: [www.pac-intl.com/#sle](http://www.pac-intl.com/#sle).
9. Sill Plate Isolation Pads: Acoustical separation between sole plate and subfloor.
- a. Products:
    - 1) AcoustiGuard – WILREP LTD; Iso-Sill Rubber Isolation Pad: [www.acoustiguard.com/#sle](http://www.acoustiguard.com/#sle).
- C. Shaft Wall Studs and Accessories: ASTM C645; galvanized sheet steel, of size and properties necessary to comply with ASTM C754 and specified performance requirements.
1. Products:
    - a. Same manufacturer as other framing materials.
- D. Area Separation Wall Studs and Accessories: ASTM C645; galvanized sheet steel, of size and properties necessary to comply with specified performance requirements.
1. Products:
    - a. Phillips Manufacturing Co; Hemmed H-Stud: [www.phillipsmfg.com/#sle](http://www.phillipsmfg.com/#sle).
- E. Partition Head To Structure Connections: Provide track fastened to structure with legs of sufficient length to accommodate deflection, for friction fit of studs cut short and fastened as indicated on drawings.
- F. Non-structural Framing Accessories:
1. Framing Connectors: ASTM A653/A653M G90 galvanized steel clips; secures cold rolled channel to wall studs for lateral bracing.
    - a. Products:
      - 1) ClarkDietrich; FastBridge Clip (FB33): [www.clarkdietrich.com/#sle](http://www.clarkdietrich.com/#sle).
  2. Flexible Wood Backing: Fire-retardant-treated wood with sheet steel connectors.
    - a. Products:
      - 1) ClarkDietrich; Danback: [www.clarkdietrich.com/#sle](http://www.clarkdietrich.com/#sle).
- G. Grid Suspension Systems: Steel grid system of main tees and support bars connected to structure using hanging wire.
1. Products:
    - a. USG Corporation; Drywall Suspension System: [www.usg.com/#sle](http://www.usg.com/#sle).

### 2.3 BOARD MATERIALS

- A. Manufacturers - Gypsum-Based Board:
1. American Gypsum Company: [www.americangypsum.com/#sle](http://www.americangypsum.com/#sle).
  2. CertainTeed Corporation: [www.certainteed.com/#sle](http://www.certainteed.com/#sle).
  3. Georgia-Pacific Gypsum: [www.gpgypsum.com/#sle](http://www.gpgypsum.com/#sle).
  4. USG Corporation: [www.usg.com/#sle](http://www.usg.com/#sle).
- B. Gypsum Wallboard: Paper-faced gypsum panels as defined in ASTM C1396/C1396M; sizes to minimize joints in place; ends square cut.
1. Application: Use for vertical surfaces and ceilings, unless otherwise indicated.
  2. Glass mat faced gypsum panels, as defined in ASTM C1658/C1658M, suitable for paint finish, of the same core type and thickness may be substituted for paper-faced board.
  3. Unfaced fiber-reinforced gypsum panels as defined in ASTM C1278/C1278M, suitable for paint finish, of the same core type and thickness may be substituted for paper-faced board.
  4. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
    - a. Mold-resistant board is required whenever board is being installed before the building is enclosed and conditioned.



- b. Mold resistant board is required at all locations.
  5. Thickness:
    - a. Vertical Surfaces: 5/8 inch.
    - b. Ceilings: 5/8 inch.
    - c. Multi-Layer Assemblies: Thicknesses as indicated on drawings.
- C. Abuse Resistant Wallboard:
  1. Application: High-traffic areas indicated.
  2. Surface Abrasion: Level 2, minimum, when tested in accordance with ASTM C1629/C1629M.
  3. Indentation: Level 1, minimum, when tested in accordance with ASTM C1629/C1629M.
  4. Soft Body Impact: Level 1, minimum, when tested in accordance with ASTM C1629/C1629M.
  5. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
  6. Paper-Faced Type: Gypsum wallboard, as defined in ASTM C1396/C1396M.
  7. Type: Fire-resistance-rated Type X, UL or WH listed.
  8. Thickness: 5/8 inch.
  9. Edges: Tapered.
  10. Paper-Faced Products:
    - a. American Gypsum Company; M-Bloc AR Type X: [www.americangypsum.com/#sle](http://www.americangypsum.com/#sle).
    - b. CertainTeed Corporation; Extreme Abuse Resistant Drywall with M2Tech: [www.certainteed.com/#sle](http://www.certainteed.com/#sle).
    - c. Georgia-Pacific Gypsum; ToughRock Fireguard X Mold Guard Abuse-Resistant: [www.gpgypsum.com/#sle](http://www.gpgypsum.com/#sle).
    - d. National Gypsum Company; Gold Bond Hi-Abuse XP Gypsum Board: [www.nationalgypsum.com/#sle](http://www.nationalgypsum.com/#sle).
    - e. USG Corporation; USG Sheetrock Brand Mold Tough AR Firecode X Panels: [www.usg.com/#sle](http://www.usg.com/#sle).
  11. Glass Mat Faced Products:
    - a. Georgia-Pacific Gypsum; DensArmor Plus Abuse-Resistant: [www.gpgypsum.com/#sle](http://www.gpgypsum.com/#sle).
    - b. National Gypsum Company; Gold Bond eXP Interior Extreme AR Gypsum Panel: [www.nationalgypsum.com/#sle](http://www.nationalgypsum.com/#sle).
    - c. USG Corporation; USG Sheetrock Brand Glass-Mat Panels Mold Tough AR Firecode X: [www.usg.com/#sle](http://www.usg.com/#sle).
- D. Ceiling Board: Special sag resistant gypsum ceiling board as defined in ASTM C1396/C1396M; sizes to minimize joints in place; ends square cut.
  1. Application: Ceilings, unless otherwise indicated.
  2. Thickness: 1/2 inch.
  3. Edges: Tapered.
  4. Products:
    - a. CertainTeed Corporation; Interior Ceiling Drywall: [www.certainteed.com/#sle](http://www.certainteed.com/#sle).
    - b. CertainTeed Corporation; 1/2" Easi-Lite: [www.certainteed.com/#sle](http://www.certainteed.com/#sle).
    - c. Continental Building Products; Sagcheck: [www.continental-bp.com/#sle](http://www.continental-bp.com/#sle).
    - d. Georgia-Pacific Gypsum; ToughRock Span 24 Ceiling Board: [www.gpgypsum.com/#sle](http://www.gpgypsum.com/#sle).
    - e. USG Corporation; 1/2 Inch Sheetrock Brand UltraLight Panels: [www.usg.com/#sle](http://www.usg.com/#sle).
- E. Acoustical Sound Dampening Wall and Ceiling Board: Two layers of heavy paper-faced, high-density gypsum board separated by a viscoelastic polymer layer and capable of achieving STC rating of 50 or more in typical stud wall assemblies as calculated in accordance with ASTM E413 and when tested in accordance with ASTM E90.
  1. Thickness: 5/8 inch.
  2. Long Edges: Tapered.
  3. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
  4. Products:
    - a. CertainTeed Corporation; SilentFX Quick Cut Gypsum Board: [www.certainteed.com/#sle](http://www.certainteed.com/#sle).
    - b. CertainTeed Corporation; SilentFX Quick Cut Type X Gypsum Board: [www.certainteed.com/#sle](http://www.certainteed.com/#sle).
    - c. National Gypsum Company; Gold Bond SoundBreak XP Gypsum Board: [www.nationalgypsum.com/#sle](http://www.nationalgypsum.com/#sle).

## 2.4 GYPSUM BOARD ACCESSORIES

- A. Acoustic Insulation: ASTM C665; preformed glass fiber, friction fit type, unfaced. Thickness: as indicated on drawings.
- B. Sound Isolation Tape: Elastomeric foam tape for sound decoupling.
  - 1. Surface Burning Characteristics: Provide assemblies with flame spread index of 75 or less and smoke developed index of 450 or less, when tested in accordance with ASTM E84.
  - 2. Tape Thickness: 1/4 inch.
  - 3. Products:
    - a. Armacell LLC; ArmaComfort MTD: [www.armacell.us/#sle](http://www.armacell.us/#sle).
- C. Acoustic Sealant: Acrylic emulsion latex or water-based elastomeric sealant; do not use solvent-based non-curing butyl sealant.
  - 1. Products:
    - a. Franklin International, Inc; Titebond GREENchoice Professional Acoustical Smoke and Sound Sealant: [www.titebond.com/#sle](http://www.titebond.com/#sle).
    - b. Liquid Nails, a brand of PPG Architectural Coatings; \_\_\_\_\_: [www.liquidnails.com/#sle](http://www.liquidnails.com/#sle).
    - c. Specified Technologies Inc; Smoke N Sound Acoustical Sealant: [www.stifirestop.com/#sle](http://www.stifirestop.com/#sle).
- D. Finishing Accessories: ASTM C1047, extruded aluminum alloy (6063 T5) or galvanized steel sheet ASTM A924/A924M G90, unless noted otherwise.
  - 1. Types: As detailed or required for finished appearance.
  - 2. Special Shapes: In addition to conventional corner bead and control joints, provide U-bead at exposed panel edges.
  - 3. Products:
    - a. Same manufacturer as framing materials.
- E. Joint Materials: ASTM C475/C475M and as recommended by gypsum board manufacturer for project conditions.
  - 1. Fiberglass Tape: 2 inch wide, coated glass fiber tape for joints and corners, except as otherwise indicated.
  - 2. Joint Compound: Setting type, field-mixed.
- F. Finishing Compound: Surface coat and primer, takes the place of skim coating.
- G. Anchorage to Substrate: Tie wire, nails, screws, and other metal supports, of type and size to suit application; to rigidly secure materials in place.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Verify that project conditions are appropriate for work of this section to commence.

### 3.2 FRAMING INSTALLATION

- A. Metal Framing: Install in accordance with ASTM C754 and manufacturer's instructions.
- B. Suspended Ceilings and Soffits: Space framing and furring members as indicated.
  - 1. Laterally brace entire suspension system.
  - 2. Install bracing as required at exterior locations to resist wind uplift.

- C. Studs: Space studs at 16 inches on center.
  - 1. Extend partition framing to structure where indicated and to ceiling in other locations.
  - 2. Partitions Terminating at Ceiling: Attach ceiling runner securely to ceiling track in accordance with manufacturer's instructions.
  - 3. Partitions Terminating at Structure: Attach extended leg top runner to structure, maintain clearance between top of studs and structure, and brace both flanges of studs with continuous bridging.
- D. Openings: Reinforce openings as required for weight of doors or operable panels, using not less than double studs at jambs.
- E. Standard Wall Furring: Install at concrete walls scheduled to receive gypsum board, not more than 4 inches from floor and ceiling lines and abutting walls. Secure in place on alternate channel flanges at maximum 24 inches on center.
  - 1. Orientation: Horizontal.
  - 2. Spacing: As indicated.
- F. Acoustic Furring: Install resilient channels at maximum 24 inches on center. Locate joints over framing members.
- G. Resilient Sound Isolation Clips: Install resilient sound isolation clips, and where applicable, associated furring sections and channels, in accordance with clip manufacturer's written instructions.
- H. Blocking: Install mechanically fastened steel sheet blocking for support of:
  - 1. Framed openings.
  - 2. Wall-mounted cabinets.
  - 3. Plumbing fixtures.
  - 4. Toilet partitions.
  - 5. Toilet accessories.
  - 6. Wall-mounted door hardware.

### 3.3 ACOUSTIC ACCESSORIES INSTALLATION

- A. Acoustic Insulation: Place tightly within spaces, around cut openings, behind and around electrical and mechanical items within partitions, and tight to items passing through partitions.
- B. Sound Isolation Tape: Apply to vertical studs and top and bottom tracks/runners in accordance with manufacturer's instructions.
- C. Acoustic Sealant: Install in accordance with manufacturer's instructions.
- D. Acoustical Shielding: Install in accordance with manufacturer's instructions for application between studs and gypsum board.

### 3.4 BOARD INSTALLATION

- A. Comply with ASTM C840, GA-216, and manufacturer's instructions. Install to minimize butt end joints, especially in highly visible locations.
- B. Single-Layer Nonrated: Install gypsum board in most economical direction, with ends and edges occurring over firm bearing.
  - 1. Exception: Tapered edges to receive joint treatment at right angles to framing.

- C. Double-Layer, Nonrated: Use gypsum board for first layer, placed parallel to framing or furring members, with ends and edges occurring over firm bearing. Use glass mat faced gypsum board at exterior walls and at other locations as indicated. Place second layer perpendicular to framing or furring members. Offset joints of second layer from joints of first layer.
- D. Fire-Resistance-Rated Construction: Install gypsum board in strict compliance with requirements of assembly listing.
- E. Exposed Gypsum Board in Interior Wet Areas: Seal joints, cut edges, and holes with water-resistant sealant.
- F. Cementitious Backing Board: Install over steel framing members and plywood substrate where indicated, in accordance with ANSI A108.11 and manufacturer's instructions.
- G. Installation on Metal Framing: Use screws for attachment of gypsum board except face layer of nonrated double-layer assemblies, which may be installed by means of adhesive lamination.
- H. Installation on Wood Framing: For rated assemblies, comply with requirements of listing authority. For nonrated assemblies, install as follows:
  - 1. Single-Layer Applications: Screw attachment.
  - 2. Double-Layer Application: Install base layer using screws or nails. Install face layer using adhesive.

### 3.5 INSTALLATION OF TRIM AND ACCESSORIES

- A. Control Joints: Place control joints consistent with lines of building spaces and as indicated.
  - 1. Not more than 30 feet apart on walls and ceilings over 50 feet long.
- B. Corner Beads: Install at external corners, using longest practical lengths.
- C. Edge Trim: Install at locations where gypsum board abuts dissimilar materials.
- D. Moisture Guard Trim: Install on bottom edge of gypsum board according to manufacturer's instructions and in locations indicated on drawings.

### 3.6 JOINT TREATMENT

- A. Glass Mat Faced Gypsum Board and Exterior Glass Mat Faced Sheathing: Use fiberglass joint tape, embed and finish with setting type joint compound.
- B. Paper Faced Gypsum Board: Use paper joint tape, embed with drying type joint compound and finish with drying type joint compound.
- C. Finish gypsum board in accordance with levels defined in ASTM C840, as follows:
  - 1. Level 4: Walls and ceilings to receive paint finish or wall coverings, unless otherwise indicated.
  - 2. Level 2: In utility areas, behind cabinetry, and on backing board to receive tile finish.
  - 3. Level 1: Areas above finished ceilings, whether or not accessible in the completed construction.
  - 4. Level 0: Temporary partitions.
- D. Tape, fill, and sand exposed joints, edges, and corners to produce smooth surface ready to receive finishes.
  - 1. Feather coats of joint compound so that camber is maximum 1/32 inch.

2. Taping, filling, and sanding are not required at surfaces behind adhesive applied ceramic tile and fixed cabinetry.
  3. Taping, filling, and sanding are not required at base layer of double-layer applications.
- E. Where Level 5 finish is indicated, spray apply high build drywall surfacer over entire surface after joints have been properly treated; achieve a flat and tool mark-free finish.
- F. Fill and finish joints and corners of cementitious backing board as recommended by manufacturer.

### 3.7 TOLERANCES

- A. Maximum Variation of Finished Gypsum Board Surface from True Flatness: 1/8 inch in 10 feet in any direction.

END OF SECTION

## SECTION 09 30 00 - TILING

### PART 1 GENERAL

#### 1.1 SECTION INCLUDES

- A. Tile for floor applications.
- B. Tile for wall applications.
- C. Non-ceramic trim.
- D. Non-ceramic trim.

#### 1.2 SUBMITTALS

- A. Product Data: Provide manufacturers' data sheets on tile, mortar, grout, and accessories. Include instructions for using grouts and adhesives.
- B. Provide 1 electronic submittal showing digital photo of full-size samples of each product.
- C. Maintenance Data: Include recommended cleaning methods, cleaning materials, and stain removal methods.
- D. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
  - 1. Extra Tile: 5 percent of each size, color, and surface finish combination. Extra tile shall be from same production runs as products installed and that are packaged with protective covering for storage and identified with labels describing contents.

#### 1.3 QUALITY ASSURANCE

- A. Installer Qualifications:
  - 1. Company specializing in performing tile installation, with minimum of five years of documented experience.

#### 1.4 DELIVERY, STORAGE, AND HANDLING

- A. Protect adhesives from freezing or overheating in accordance with manufacturer's instructions.
- B. Delivery, storage, and handling in accordance with manufacturer's instructions.
- C. Store tile and cementitious materials on elevated platforms, under cover, and in a dry location.

#### 1.5 FIELD CONDITIONS

- A. Do not install solvent-based products in an unventilated environment.
- B. Maintain ambient and substrate temperature above 50 degrees F and below 100 degrees F during installation and curing of setting materials.

## PART 2 PRODUCTS

### 2.1 TILE

- A. Manufacturers: As indicated on Drawings.
  - 1. Substitutions not permitted.

### 2.2 TRIM AND ACCESSORIES

- A. Non-Ceramic Trim: Satin natural anodized extruded aluminum, style and dimensions to suit application, for setting using tile mortar or adhesive.
  - 1. Applications:
    - a. Outside vertical corner trim at tile walls.
    - b. Transition between floor finishes of different heights.
    - c. Thresholds at door openings.
  - 2. Manufacturers:
    - a. Schluter-Systems: [www.schluter.com/#sle](http://www.schluter.com/#sle).

### 2.3 SETTING MATERIALS

- A. Provide setting and grout materials from same manufacturer.
- B. Manufacturers:
  - 1. As indicated on Drawings.
- C. Latex Modified Cement Mortar
  - 1. Applications: Use this type of bond coat where indicated, and where no other type of bond coat is indicated.
  - 2. Products:
    - a. H.B. Fuller Construction Products, Inc; TEC Ultimate 6 Plus Mortar: [www.tecspecialty.com/#sle](http://www.tecspecialty.com/#sle).

### 2.4 GROUTS

- A. Provide setting and grout materials from same manufacturer.
- B. High Performance Polymer Modified Grout: ANSI A118.7 polymer modified cement grout.
  - 1. Applications: General floor and wall tile.
  - 2. Use unsanded grout for joints less than 1/8 inch wide.
  - 3. Color(s): As indicated on drawings.
  - 4. Products: TEC Incolor performance grout.

### 2.5 MAINTENANCE MATERIALS

- A. Tile Sealant: Gunnable, silicone, siliconized acrylic, or urethane sealant; moisture and mildew resistant type.
  - 1. Applications: Between tile and plumbing fixtures, soft joints in tile, floor/wall intersections of tiled walls.
  - 2. Color(s): Match grout color.
  - 3. Products: Same as grout manufacturer.

### PART 3 EXECUTION

#### 3.1 EXAMINATION

- A. Verify that subfloor surfaces are smooth and flat within the tolerances specified for that type of work, are dust free and free of substances that could impair bonding of setting materials to subfloor surfaces, and are ready to receive tile.
- B. Verify that wall surfaces are smooth and flat within the tolerances specified for that type of work, are dust-free, and are ready to receive tile.
- C. Maximum variation from the required plane (as specified by Tile Council of America).
  - 1. Tiles with no edges greater than 15 inches, floors and walls: 1/4 inch in 10 feet and/or 1/16 inch in 1 foot.
  - 2. Tiles with at least on edge greater than 15 inches, floors and walls: 1/8 inch in 10 feet, and/or 1/16 inch in 2 feet.
- D. Verify that required floor-mounted utilities are in correct location.
- E. Notify Architect and General Contractor in writing of unsatisfactory conditions.

#### 3.2 PREPARATION

- A. Protect surrounding work from damage.
- B. Vacuum clean surfaces and damp clean.
- C. Seal substrate surface cracks with filler. Level existing substrate surfaces to acceptable flatness tolerances.
- D. Prepare substrate surfaces for adhesive installation in accordance with adhesive manufacturer's instructions.

#### 3.3 INSTALLATION - GENERAL

- A. Install tile and grout in accordance with manufacturer's instructions, applicable requirements on ANSI A108.1a through ANSI A108.20, and TCNA (HB) recommendations.
- B. Install Latex Modified Portland Cement Mortar in accordance with ANSI A108 Installation Specifications.
- C. Lay tile to pattern indicated on Drawings. Do not interrupt tile pattern through openings. Changes in pattern from room to room shall change at centerline of door threshold.
- D. Cut and fit tile to penetrations through tile, leaving sealant joint space. Form corners and bases neatly. Align floor joints.
- E. Place tile joints uniform in width, subject to variance in tolerance allowed in tile size. Make grout joints without voids, cracks, excess mortar or excess grout, or too little grout.
- F. Form internal angles square and external angles bullnosed.



- G. Install ceramic accessories rigidly in prepared openings.
- H. Install non-ceramic trim in accordance with manufacturer's instructions.
- I. Install thresholds where indicated.
- J. Sound tile after setting. Replace hollow sounding units.
- K. Keep control and expansion joints free of mortar, grout, and adhesive.
- L. Prior to grouting, allow installation to completely cure; minimum of 48 hours.
- M. Grout tile joints unless otherwise indicated. Use standard grout unless otherwise indicated.
- N. At changes in plane and tile-to-tile control joints, use tile sealant instead of grout, with either bond breaker tape or backer rod as appropriate to prevent three-sided bonding.

#### 3.4 INSTALLATION - FLOORS - THIN-SET METHODS

- A. Over interior concrete substrates, install in accordance with TCNA (HB) Method F113, dry-set or latex-Portland cement bond coat, with standard grout, unless otherwise indicated.
  - 1. Use uncoupling membrane under all tile unless other underlayment is indicated.
- B. Install tile-to-tile floor movement joints in accordance with TCNA (HB) Method EJ171F.

#### 3.5 INSTALLATION - WALL TILE

- A. Over cementitious backer units install in accordance with TCNA (HB) Method W223, organic adhesive.

#### 3.6 CLEANING

- A. Clean tile and grout surfaces.

#### 3.7 PROTECTION

- A. Do not permit traffic over finished floor surface for 4 days after installation.

END OF SECTION

## SECTION 09 51 00 - ACOUSTICAL CEILINGS

### PART 1 GENERAL

#### 1.1 SECTION INCLUDES

- A. Suspended metal grid ceiling system.
- B. Acoustical units.

#### 1.2 ADMINISTRATIVE REQUIREMENTS

- A. Sequence work to ensure acoustical ceilings are not installed until building is enclosed, sufficient heat is provided, dust generating activities have terminated, and overhead work is completed, tested, and approved.
- B. Do not install acoustical units until after interior wet work is dry.

#### 1.3 SUBMITTALS

- A. Product Data: Provide data on suspension system components and acoustical units.
- B. Samples: Submit two samples illustrating material and finish of acoustical units.
- C. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
  - 1. Extra Acoustical Units: Quantity equal to 5 percent of total installed.

#### 1.4 QUALITY ASSURANCE

- A. Suspension System Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- B. Acoustical Unit Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

#### 1.5 FIELD CONDITIONS

- A. Maintain uniform temperature of minimum 60 degrees F, and maximum humidity of 40 percent prior to, during, and after acoustical unit installation.

### PART 2 PRODUCTS

#### 2.1 MANUFACTURERS

- A. Acoustic Tiles/Panels:
  - 1. USG Corporation; \_\_\_\_: [www.usg.com/ceilings/#sle](http://www.usg.com/ceilings/#sle), as indicated on Drawings.
- B. Suspension Systems:
  - 1. Same as acoustical units, as indicated on Drawings.

## 2.2 ACOUSTICAL UNITS

- A. Acoustical Units - General: ASTM E1264, Class A.

## 2.3 SUSPENSION SYSTEM(S)

- A. Metal Suspension Systems - General: Complying with ASTM C635/C635M; die cut and interlocking components, with perimeter moldings, hold down clips, stabilizer bars, clips, and splices as required.

## 2.4 ACCESSORIES

- A. Support Channels and Hangers: Galvanized steel; size and type to suit application, seismic requirements, and ceiling system flatness requirement specified.
- B. Hanger Wire: 12 gauge, 0.08 inch galvanized steel wire.
- C. Hold-Down Clips: Manufacturer's standard clips to suit application.
- D. Perimeter Moldings: Same metal and finish as grid.
  - 1. Angle Molding: L-shaped, for mounting at same elevation as face of grid.
  - 2. Gaskets For Perimeter Moldings: Closed-cell foam, factory-applied to molding.
  - 3. Acoustical Sealant For Perimeter Moldings: Non-hardening, non-skinning, for use in conjunction with suspended ceiling system.
- E. Gypsum Board: Fire rated type; 5/8 inch thick, ends and edges square, paper faced.
- F. Touch-up Paint: Type and color to match acoustical and grid units.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Examine areas to receive ceiling panels for conditions that will adversely affect installation. Provide written report inspection of discrepancies.
- C. Do not start work until unsatisfactory conditions are corrected.
- D. Work to be concealed: Verify work above ceiling is complete and installed in manner that will not affect layout and installation of ceiling panels.
- E. Verify that layout of hangers will not interfere with other work.

### 3.2 PREPARATION

- A. Install after major above-ceiling work is complete.
- B. Coordinate the location of hangers with other work.
- C. Start of installation constitutes e

- D. Field dimensions must be verified prior to installation.

### 3.3 INSTALLATION - SUSPENSION SYSTEM

- A. Install suspension system in accordance with ASTM C636/C636M, ASTM E580/E580M, and manufacturer's instructions and as supplemented in this section.
- B. Rigidly secure system, including integral mechanical and electrical components, for maximum deflection of 1:360.
- C. Locate system on room axis according to reflected plan.
- D. Perimeter Molding: Install at intersection of ceiling and vertical surfaces and at junctions with other interruptions.
  - 1. Install in bed of acoustical sealant.
  - 2. Use longest practical lengths.
  - 3. Overlap and rivet corners.
- E. Suspension System, Non-Seismic: Hang suspension system independent of walls, columns, ducts, pipes and conduit. Where carrying members are spliced, avoid visible displacement of face plane of adjacent members.
- F. Where ducts or other equipment prevent the regular spacing of hangers, reinforce the nearest affected hangers and related carrying channels to span the extra distance.
- G. Do not support components on main runners or cross runners if weight causes total dead load to exceed deflection capability.
- H. Support fixture loads using supplementary hangers located within 6 inches of each corner, or support components independently.
- I. Do not eccentrically load system or induce rotation of runners.
- J. Form expansion joints as detailed. Form to accommodate plus or minus 1 inch movement. Maintain visual closure.

### 3.4 INSTALLATION - ACOUSTICAL UNITS

- A. Install acoustical units in accordance with manufacturer's instructions.
- B. Fit acoustical units in place, free from damaged edges or other defects detrimental to appearance and function.
- C. Fit border trim neatly against abutting surfaces.
- D. Install acoustical units level, in uniform plane, and free from twist, warp, and dents.
- E. Cutting Acoustical Units:
  - 1. Cut to fit irregular grid and perimeter edge trim.
  - 2. Make field cut edges of same profile as factory edges.
  - 3. Double cut and field paint exposed reveal edges.

### 3.5 TOLERANCES

- A. Maximum Variation from Flat and Level Surface: 1/8 inch in 10 feet.
- B. Maximum Variation from Plumb of Grid Members Caused by Eccentric Loads: 2 degrees.

### 3.6 CLEANING

- A. Clean exposed surfaces of acoustical panel ceilings, including trim, edge moldings, and suspension system members. Comply with manufacturer's written instructions for cleaning and touch up of minor finish damage. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION

## SECTION 09 54 00 – SPECIALTY CEILINGS

### PART 1 GENERAL

#### 1.1 SECTION INCLUDES

- A. Specialty ceiling panels and systems.
- B. Metal suspension system.

#### 1.2 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate work of this section with installation of mechanical and electrical components and with other construction activities affected by work of this section.
- B. Sequence work to ensure ceilings are not installed until building is enclosed, dust generating activities have terminated, and overhead work is completed.

#### 1.3 SUBMITTALS

- A. Product Data: Submit for each type of material.
- B. Shop Drawings: Indicate grid layout and related dimensioning, attachment of specialty ceiling panels to grid, accessory attachments, junctions with other ceiling finishes, and mechanical and electrical items installed in the ceiling.
- C. Provide two samples, each 6 inches by 6 inches of each specialty ceiling.

#### 1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- B. Installer Qualifications: Company specializing in performing the work of this section.
  - 1. Minimum 5 years documented experience.
  - 2. Approved by ceiling manufacturer.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver specialty ceiling components to project site in original, unopened packages.
- B. Store in fully enclosed space, flat, level and off the floor.

#### 1.6 FIELD CONDITIONS

- A. Do not install specialty ceiling system until wet construction work is complete and permanent heat and air conditioning is installed and operating.

### PART 2 PRODUCTS

#### 2.1 SPECIALTY CEILING ASSEMBLIES

- A. Refer to Reflection Ceiling Plans and Finish Legend on drawings for additional ceiling assemblies information.

- B. Specialty Ceiling Assembly Type MCT1.
  - 1. Panels: WireWorks Open Cell Ceiling Panels
    - a. Color: As indicated on drawings.
  - 2. Standard Suspension System: As indicated on drawings.

## 2.2 PERFORMANCE REQUIREMENTS

- A. Design for maximum deflection of 1/360 of span.
- B. Design to support imposed loads of indicated elements without eccentric loading of supports. Where supported elements may induce rotation of ceiling system components, provide stabilizing reinforcement.

## 2.3 COMPONENT PRODUCTS

- A. Panels:
  - 1. Open-Cell Panels: Wire grid lay-in panels.
    - a. 1 inch by 1 inch cells.
    - b. Wire Thickness: 1/8 inch.
    - c. Finish: As indicated on drawings.
    - d. Products: USG Corporation
      - 1) Substitutions not permitted.
- B. Standard Suspension Systems:
  - 1. Metal Suspension Systems: Gridware. Refer to drawings.
    - a. 9/16" profile
    - b. Color: As indicated on drawings.
    - c. Products: USG Corporation.
      - 1) Substitutions not permitted.
- C. Moldings and Trim:
  - 1. Edge Trim Molding: Manufacturer's standard edge trim.
    - a. Color to match suspension system.
  - 2. Perimeter Moldings: Same metal and finish as grid.
    - a. Size: As required for installation conditions.
    - b. Angle Moldings: L-shaped, for mounting at same elevation as face of grid.

## 2.4 ACCESSORIES

- A. Support Channels, Carriers, and Hangers: Primed steel; size and type to suit application.
  - 1. Exposed to view Suspension
    - a. Suspension Wire: Stainless steel.
- B. Unopposed Tee Attachment Clip: Manufacturer's standard clip designed to create code-compliant cross tee connections when a cross tee is installed in a main tee without another cross tee directly opposite.
- C. Touch-Up Paint for Exposed Surfaces: Type and color to match metal wire units and suspension system grid and trim elements.

## 2.5 FABRICATION

- A. Shop fabricate ceiling components to the greatest extent possible.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Examine areas to receive ceiling panels for conditions that will adversely affect installation. Provide written report inspection of discrepancies.
- C. Verify that work above ceiling that will be covered is complete and installed in a manner that will not affect layout and installation of ceiling panels.
- D. Verify that layout of hangers will not interfere with other work.
- E. Verify that field measurements are as indicated on shop drawings.
- F. Do not begin installation until after interior wet work is dry.
- G. Start of installation constitutes acceptance of project condition.

### 3.2 PREPARATION

- A. Coordinate the location of hangers with other work.
- B. Install after major above-ceiling work is complete.
- C. Layout ceiling components in pattern according to reflected ceiling plan and as shown on shop drawings.

### 3.3 INSTALLATION – SUSPENSION SYSTEM

- A. Install suspension system in accordance with manufacturer's instructions and as supplemented in this section.
- B. Install hangers and inserts coordinated with overhead work. Provide additional hangers and supports as required.
- C. Rigidly secure system, including integral mechanical and electrical components, for maximum deflection of 1:360.
- D. Locate system on room axis according to reflected ceiling plan.
- E. Suspension System, Non-Seismic: Hang suspension system independent of walls, columns, ducts, pipes, and conduit. Where carrying members are spliced, avoid visible displacement of face plane of adjacent members.
- F. Where ducts, facility services, or equipment prevent the regular spacing of hangers, reinforce the nearest affected hangers and related carrying channels to span the extra distance.
- G. Do not support components on main runners or cross runners if weight causes total dead load to exceed deflection capability.
- H. Support fixture loads using supplementary hangers located within 6 inches (152 mm) of each corner, or support components independently.



- I. Do not eccentrically load system or induce rotation of runners.
- J. Edge Moldings: Install at intersection of ceiling and vertical surfaces and penetrations, using components of maximum length, set level. Provide edge moldings at junction with other ceiling finishes. Miter corners. Provide preformed edge closures to match bullnosed cornered partitions.
  - 1. Use longest practical lengths.
- K. Assemble corners according to manufacturer's instructions corners to backer angles according to manufacturer's instructions.

#### 3.4 INSTALLATION – SPECIALTY CEILING UNITS

- A. Install in accordance with manufacturer's instructions.
- B. Fit components in place, free from damaged edges or other defects detrimental to appearance and function.
- C. Cut to fit irregular grid and perimeter moldings.
  - 1. Shape and finish field-cut edges as recommended by manufacturer to match profile of factory edges and finish.
- D. Fit edge trim neatly against abutting surfaces.
- E. Install specialty units level and free from twist, warp, and dents.
- F. Hang specialty units from suspension grid by engaging torsion springs into main tees.
- G. Where round obstructions occur, provide preformed closures to match perimeter molding.
- H. Bend hold-down tabs onto each panel to retain panels tight to grid system; comply with fire rating requirements, and where required by manufacturer.

#### 3.5 TOLERANCES

- A. Maximum Variation from Indicated Planes: 1/8 inch in 10 feet.
- B. Maximum Variation from Plumb of Grid Members Caused by Eccentric Loads: 2 degrees.

#### 3.6 CLEANING

- A. Clean and touch up minor finish damage. Remove and replace components that cannot be successfully cleaned and repaired.

END OF SECTION

## SECTION 09 65 00 - RESILIENT FLOORING

### PART 1 GENERAL

#### 1.1 SECTION INCLUDES

- A. Luxury Vinyl Tile.
- B. Rubber floor tile.
- C. Rubber stair treads and risers.
- D. Rubber base.
- E. Transition strips.
- F. Installation accessories.

#### 1.2 SUBMITTALS

- A. Product Data: Provide data on specified products, describing physical and performance characteristics; including sizes, patterns and colors available; and installation instructions.
- B. Selection Samples: Submit 1 electronic submittal showing digital photo of full-size samples of each product.
- C. Maintenance Data: Include maintenance procedures, recommended maintenance materials, and suggested schedule for cleaning, stripping, and re-waxing.

#### 1.3 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing specified flooring with minimum three years documented experience.
- B. Installer Qualifications: Company specializing in installing specified flooring with minimum three years documented experience.

#### 1.4 DELIVERY, STORAGE, AND HANDLING

- A. Upon receipt, immediately remove any shrink-wrap and check materials for damage and the correct style, color, quantity and run numbers.
- B. Store all materials off of the floor in an acclimatized, weather-tight space.
- C. Maintain temperature in storage area between 55 degrees F and 90 degrees F.
- D. Do not double stack pallets.

## 1.5 FIELD CONDITIONS

- A. Store materials for not less than 48 hours prior to installation in area of installation at a temperature of 70 degrees F to achieve temperature stability. Thereafter, maintain conditions above 55 degrees F.

## PART 2 PRODUCTS

### 2.1 TILE FLOORING

- A. Luxury Vinyl Tile: Printed film type, with transparent or translucent wear layer; acoustic interlayer or backing.
  - 1. Manufacturers: See Finish Material Legend and Finish Plan on Drawings.
    - a. Substitutions not permitted.
  - 2. Plank Tile Size: As indicated on Drawings.
  - 3. Pattern: As indicated on Drawings.
  - 4. Color: As indicated on Drawings.
- B. Rubber Tile: Homogeneous, color and pattern throughout thickness.
  - 1. Manufacturers: See Finish Material Legend and Finish Plan on Drawings.
    - a. Substitutions not permitted.
  - 2. Minimum Requirements: Comply with ASTM F1344, of Class corresponding to type specified.
  - 3. Size: As indicated on Drawings.
  - 4. Total Thickness: 0.125 inch.
  - 5. Texture: As indicated on Drawings.
  - 6. Color: As indicated on drawings.

### 2.2 STAIR COVERING

- A. Stair Treads with Integral Risers: Rubber; full height of riser, full width and depth of tread in one piece; tapered thickness.
  - 1. Manufacturers: See Finish Material Legend and Finish Plan on Drawings.
    - a. Substitutions not permitted.
  - 2. Minimum Requirements: Comply with ASTM F2169, Type TS, rubber, vulcanized thermoset.
  - 3. Tread Texture: As indicated on drawings.
  - 4. Color: As indicated on drawings.

### 2.3 RESILIENT BASE

- A. Resilient Base: ASTM F1861, Type TS rubber, vulcanized thermoset; style as scheduled.
  - 1. Manufacturers: See Finish Material Legend and Finish Plan on Drawings.
    - a. Substitutions not permitted.
  - 2. Height: 4 inch.
  - 3. Thickness: 0.125 inch.
  - 4. Finish: Satin.
  - 5. Profile: As indicated on drawings.
  - 6. Color: As indicated on drawings.

### 2.4 ACCESSORIES

- A. Subfloor Filler: White premix latex; type recommended by adhesive material manufacturer.
- B. Primers, Adhesives, and Seam Sealer: Waterproof; types recommended by flooring manufacturer.
- C. Transition Strips: As indicated on Drawings.

- D. Other Materials: Provide incidental and accessory materials, tools, methods and equipment required for completion of resilient base installation.

### PART 3 EXECUTION

#### 3.1 EXAMINATION

- A. Verify that surfaces are flat to tolerances acceptable to flooring manufacturer, free of cracks that might telegraph through flooring, clean, dry, and free of curing compounds, surface hardeners, and other chemicals that might interfere with bonding of flooring to substrate.
- B. Verify that wall surfaces are smooth and flat within the tolerances specified for that type of work, are dust-free, and are ready to receive resilient base.
- C. Cementitious Subfloor Surfaces: Verify that substrates are ready for resilient flooring installation by testing for moisture and alkalinity (pH).
  - 1. Obtain instructions if test results are not within limits recommended by resilient flooring manufacturer and adhesive materials manufacturer.
- D. Verify that required floor-mounted utilities are in correct location.

#### 3.2 PREPARATION

- A. Remove existing resilient flooring and flooring adhesives; follow the recommendations of RFCI (RWP).
- B. Prepare floor substrates as recommended by flooring and adhesive manufacturers.
- C. Remove subfloor ridges and bumps. Fill minor low spots, cracks, joints, holes, and other defects with subfloor filler to achieve smooth, flat, hard surface.
- D. Prohibit traffic until filler is fully cured.

#### 3.3 INSTALLATION - GENERAL

- A. Starting installation constitutes acceptance of subfloor conditions.
- B. Install in accordance with manufacturer's written instructions.
- C. Install edge strips at unprotected or exposed edges, where flooring terminates, and where indicated.
- D. Scribe flooring to walls, columns, cabinets, floor outlets, and other appurtenances to produce tight joints.

#### 3.4 INSTALLATION - TILE FLOORING

- A. Mix tile from container to ensure shade variations are consistent when tile is placed, unless otherwise indicated in manufacturer's installation instructions.

#### 3.5 INSTALLATION - RESILIENT BASE

- A. Fit joints tightly and make vertical. Maintain minimum dimension of 18 inches between joints.

- B. Install base on solid backing. Bond tightly to wall and floor surfaces.

### 3.6 INSTALLATION - STAIR COVERINGS

- A. Install stair coverings in one piece for full width and depth of tread.
- B. Install stringers configured tightly to stair profile.
- C. Adhere over entire surface. Fit accurately and securely.

### 3.7 CLEANING

- A. Remove excess adhesive from floor, base, and wall surfaces without damage.
- B. Clean in accordance with manufacturer's written instructions.

### 3.8 PROTECTION

- A. Prohibit traffic on resilient flooring for 48 hours after installation.
- B. Cover finished flooring with reinforced kraft paper and maintain until construction is complete and accepted by Owner. Repair or replace covering damage during construction period.

END OF SECTION

## SECTION 09 68 13 - TILE CARPETING

### PART 1 GENERAL

#### 1.1 SECTION INCLUDES

- A. Carpet tile, fully adhered.
- B. Removal of existing carpet tile.

#### 1.2 SUBMITTALS

- A. Product Data: Provide data on specified products, describing physical and performance characteristics; sizes, patterns, colors available, and method of installation.
- B. Samples: Submit two carpet tiles illustrating color and pattern design for each carpet color selected.

#### 1.3 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing specified carpet tile with minimum three years documented experience.
- B. Installer Qualifications: Company specializing in installing carpet tile with minimum three years documented experience and approved by carpet tile manufacturer.

#### 1.4 FIELD CONDITIONS

- A. Store materials in area of installation for minimum period of 24 hours prior to installation.

### PART 2 PRODUCTS

#### 2.1 MANUFACTURERS

- A. Tile Carpeting: See Finish Legend on Drawings for manufacturer, product, style, color, size, etc. No substitutions permitted.

#### 2.2 ACCESSORIES

- A. Subfloor Filler: White premix latex; type recommended by flooring material manufacturer.
- B. Flooring Primer: As recommended by flooring material manufacturer.
- C. Edge Strips: As indicated on Drawings.
- D. Carpet Tile Adhesive: Recommended by carpet tile manufacturer for intended use and suitable for concrete Rh and Ph; resealable type.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Verify that subfloor surfaces are smooth and flat within tolerances specified for that type of work and are ready to receive carpet tile.
- B. Verify that subfloor surfaces are dust-free and free of substances that could impair bonding of adhesive materials to subfloor surfaces.
- C. Cementitious Subfloor Surfaces: Verify that substrates are ready for flooring installation by testing for moisture and alkalinity (pH).
  - 1. Obtain instructions if test results are not within limits recommended by flooring material manufacturer and adhesive materials manufacturer.
- D. Verify that required floor-mounted utilities are in correct location.

### 3.2 PREPARATION

- A. Remove existing carpet tile and send back to manufacturer for recycling, if available.
- B. Prepare floor substrates as recommended by flooring and adhesive manufacturers.
- C. Remove subfloor ridges and bumps. Fill minor or local low spots, cracks, joints, holes, and other defects with subfloor filler.
- D. Apply, trowel, and float filler to achieve smooth, flat, hard surface. Prohibit traffic until filler is cured.
- E. Vacuum clean substrate.

### 3.3 INSTALLATION

- A. Starting installation constitutes acceptance of subfloor conditions.
- B. Install carpet tile in accordance with manufacturer's instructions.
- C. Blend carpet from different cartons to ensure minimal variation in color match.
- D. Cut carpet tile clean. Fit carpet tight to intersection with vertical surfaces without gaps.
- E. Lay carpet tile with pile direction parallel to next unit, set parallel to building lines. Refer to drawings to carpet installation pattern and direction.
- F. Locate change of color or pattern between rooms under door centerline.
- G. Fully adhere carpet tile to substrate.
- H. Trim carpet tile neatly at walls and around interruptions.
- I. Complete installation of edge strips, concealing exposed edges.

3.4 CLEANING

- A. Remove excess adhesive without damage, from floor, base, and wall surfaces.
- B. Clean and vacuum carpet surfaces.

END OF SECTION



## SECTION 09 77 00 - FIBERGLASS REINFORCED WALL PANELS

### PART 1 GENERAL

#### 1.1 SECTION INCLUDES

- A. Prefinished polyester glass reinforced plastic sheets and adhered to unfinished gypsum board.
  - 1. PVC trim.
  - 2. PVC wall base.
- B. Mounting accessories.

#### 1.2 SUBMITTALS

- A. Product Data: Manufacturer's printed data sheets for products specified.
- B. Shop Drawings: Fabrication and installation details.
- C. Samples for Verification: Submit digital image of samples.

#### 1.3 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials factory packaged on strong pallets.
- B. Store panels and trim laying flat, under cover and protected from the elements. Allow panels to acclimate to room temperature (range of 60 to 75°F) for 48 hours prior to installation.

#### 1.4 PROJECT CONDITIONS

- A. Environmental Limitations: Building are to be fully enclosed prior to installation with sufficient heat (70°) and ventilation consistent with good working conditions for finish work.
- B. During installation and fore not less than 48 hours before, maintain an ambient temperature and relative humidity within limits required by type of adhesive used and recommendation of adhesive manufacturer.
  - 1. Provide ventilation to disperse fumes during application of adhesive as recommended by the adhesive manufacturer.

### PART 2 PRODUCTS

#### 2.1 ACCEPTABLE MANUFACTURER

- A. Marlite; 1 Marlite Drive, Dover, OH 44622. 800-377-1221 FAX (330) 343-4668 Email: [info@marlite.com](mailto:info@marlite.com)  
[www.marlite.com](http://www.marlite.com).
- B. Product: Standard FRP.

## 2.2 PANELS

- A. Fiberglass reinforced thermosetting polyester resin panel sheets complying with ASTM D 5319.
  - 1. Dimensions:
    - a. Thickness – 0.090 " (2.29mm) nominal
    - b. Width - 4'-0" (1.22m) nominal
    - c. Length – [10'-0" (3.0m)][8'-0" (2.4m)] [As indicated on the drawings] nominal
  - 2. Tolerance:
    - a. Length and Width: +/-1/8 " (3.175mm)
    - b. Square - Not to exceed 1/8 " for 8 foot (2.4m) panels or 5/32 " (3.96mm) for 10 foot (2.4m) panels
- B. Properties: Resistant to rot, corrosion, staining, denting, peeling, and splintering.
  - 1. Flexural Strength -  $1.7 \times 10^4$  psi per ASTM D 790.
  - 2. Flexural Modulus –  $6.0 \times 10^5$  psi per ASTM D 790.
  - 3. Tensile Strength –  $8.0 \times 10^3$  psi per ASTM D 638.
  - 4. Tensile Modulus –  $9.43 \times 10^5$  psi per ASTM D 638.
  - 5. Water Absorption - 0.17% per ASTM D 570.
  - 6. Barcol Hardness (scratch resistance) of 30 as per ASTM D 2583.
  - 7. Izod Impact Strength of 7.0 ft. lbs./in ASTM D 256.
- C. Back surface: Smooth. Imperfections which do not affect functional properties are not cause for rejection.
- D. Front Finish: As indicated on Drawings.

## 2.3 BASE

- A. Marlite Base Molding for 0.090" (2.29mm) thick FRP Panels.
  - 1. Color: Black
  - 2. Profiles:
    - a. M 612 FRP Base Molding, 10' length.
    - b. M 651 Inside Corner
    - c. M 620 LH End Cap
    - d. M 625 RH End Cap

## 2.4 MOLDINGS

- A. PVC Trim: Thin-wall semi-rigid extruded PVC.
  - 1. M 350 Inside Corner
  - 2. M 365 Division
  - 3. M 370 Edge
  - 4. Color: White

## 2.5 ACCESSORIES

- A. Fasteners: Non-staining nylon drive rivets.
  - 1. Match panel colors.
  - 2. Length to suit project conditions.
- B. Adhesive: Construction adhesive complying with ASTM C 557 as recommended by manufacturer:
  - 1. Titebond Advanced Polymer Panel Adhesive – VOC compliant, non-flammable, environmentally safe adhesive.
- C. Sealant: Marlite Brand MS-251 White Silicone Sealant.

## PART 3 EXECUTION

### 3.1 PREPARATION

- A. Examine backup surfaces to determine that corners are plumb and straight, surfaces are smooth, uniform, clean and free from foreign matter, nails countersunk, joints and cracks filled flush and smooth with the adjoining surface.
  - 1. Verify that stud spacing does not exceed 24" on-center.

### 3.2 INSTALLATION

- A. Comply with manufacturer's recommended procedures and installation sequence.
- B. Cut sheets to meet supports allowing 1/8" clearance for every 8 foot of panel.
  - 1. Cut and drill with carbide tipped saw blades or drill bits, or cut with shears.
  - 2. Pre-drill fastener holes 1/8" oversize with high speed drill bit.
    - a. Space at 8" (200mm) maximum on center at perimeter, approximately 1" from panel edge.
    - b. Space in field in rows 16" on center, with fasteners spaced at 12" maximum on center.
- C. Apply panels to board substrate, above base, vertically oriented with seams plumb and pattern aligned with adjoining panels.
  - 1. Install panels with manufacturer's recommended gap for panel field and corner joints.
    - a. Adhesive trowel and application method to conform to adhesive manufacturer's recommendations.
    - b. Drive fasteners for snug fit. Do not over-tighten.
- D. Apply panel moldings to all panel edges using silicone sealant providing for required clearances.
  - 1. All moldings must provide for a minimum 1/8" of panel expansion at joints and edges, to insure proper installation.
  - 2. Apply sealant to all moldings, channels and joints between the system and different materials to assure watertight installation.

### 3.3 CLEANING

- A. Remove excess sealant from panels and moldings. Wipe panel down using a damp cloth and mild soap solution or cleaner.
- B. Refer to manufacturer's specific cleaning recommendations. Do not use abrasive cleaners.

END OF SECTION

## SECTION 09 84 30 - SOUND-ABSORBING WALL AND CEILING UNITS

### PART 1 GENERAL

#### 1.1 SECTION INCLUDES

- A. Sound-absorbing ceiling baffles.
- B. Mounting accessories.

#### 1.2 SUBMITTALS

- A. Product Data: Manufacturer's printed data sheets for products specified.
- B. Shop Drawings: Fabrication and installation details.

#### 1.3 DELIVERY, STORAGE, AND HANDLING

- A. Protect acoustical units from moisture during shipment, storage, and handling. Deliver in factory-wrapped bundles; do not open bundles until units are needed for installation.
- B. Store units flat, in dry, well-ventilated space; do not stand on end.
- C. Protect edges from damage.

### PART 2 PRODUCTS

#### 2.1 SOUND-ABSORBING UNITS

- A. Manufacturers:
  - 1. Basis of Design: Turf
    - a. Slab Ceiling Baffle.
    - b. Equal substitutions will be considered upon Owner and Architect's determination.
- B. General:
  - 1. Prefinished, factory assembled PET panels.
  - 2. Surface Burning Characteristics: Flame spread index of 25 or less and smoke developed index of 450 or less, when tested in accordance with ASTM E84.
  - 3. Contains 60% pre-consumer recycled PET fibers.
- C. Acoustical Ceiling Baffles:
  - 1. Baffle Core: Hollow.
  - 2. Color: As indicated on drawings.
  - 3. Mounting: Feltlock with cables vertically suspended from ceiling or structure.
  - 4. Spacing: 10 inches on center.

#### 2.2 FABRICATION

- A. Fabricate panels to sizes and configurations as indicated on drawings.
- B. Tolerances: Fabricate to finished tolerance of plus or minus 1/16 inch for thickness, overall length and width, and squareness from corner to corner.

## 2.3 ACCESSORIES

- A. Ceiling-Suspended Accessories: Manufacturer's standard accessories at locations as indicated on each acoustical unit, sized appropriately for weight of acoustical unit.
  - 1. Provide P1000T Unistrut, powder-coated white. Suspend Unistrut from deck above.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates for conditions detrimental to installation of acoustical units. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Install acoustical units in locations as indicated, following manufacturer's installation instructions and best practices.
- B. Install mounting accessories and supports in accordance with shop drawings and manufacturers recommendations.
- C. Align panels accurately, with edges plumb and top edges level. Scribe to fit accurately at adjoining work and penetrations.
- D. Suspend ceiling baffles at locations and heights as indicated.
- E. Install acoustical units to construction tolerances of plus or minus 1/16 inch for the following:
  - 1. Plumb and level.
  - 2. Flatness.
  - 3. Width of joints.

### 3.3 CLEANING

- A. Clean sound-absorptive panels upon completion of installation from dust and other foreign materials, following manufacturer's instructions.

### 3.4 PROTECTION

- A. Provide protection of installed acoustical panels until Date of Substantial Completion.
- B. Replace panels that cannot be cleaned and repaired to satisfaction of the Architect and Owner.

END OF SECTION

## SECTION 09 91 23 - INTERIOR PAINTING

### PART 1 GENERAL

#### 1.1 SECTION INCLUDES

- A. Surface preparation.
- B. Field application of paints.
- C. Scope: Finish interior surfaces exposed to view, unless fully factory-finished and unless otherwise indicated.
  - 1. Both sides and edges of plywood backboards for electrical and telecom equipment before installing equipment.
  - 2. Surfaces inside cabinets.
  - 3. Prime surfaces to receive wall coverings.
  - 4. Mechanical and Electrical:
    - a. In finished areas, paint insulated and exposed pipes, conduit, boxes, insulated and exposed ducts, hangers, brackets, collars and supports, mechanical equipment, and electrical equipment, unless otherwise indicated.
    - b. In finished areas, paint shop-primed items.
    - c. Paint interior surfaces of air ducts and convector and baseboard heating cabinets that are visible through grilles and louvers with one coat of flat black paint to visible surfaces.
    - d. Paint dampers exposed behind louvers, grilles, and convector and baseboard cabinets to match face panels.
- D. Do Not Paint or Finish the Following Items:
  - 1. Items factory-finished unless otherwise indicated; materials and products having factory-applied primers are not considered factory finished.
  - 2. Items indicated to receive other finishes.
  - 3. Items indicated to remain unfinished.
  - 4. Fire rating labels, equipment serial number and capacity labels, bar code labels, and operating parts of equipment.
  - 5. Stainless steel, anodized aluminum, bronze, terne coated stainless steel, and lead items.
  - 6. Marble, granite, slate, and other natural stones.
  - 7. Floors, unless specifically indicated.
  - 8. Ceramic and other tiles.
  - 9. Brick, architectural concrete, cast stone, integrally colored plaster and stucco.
  - 10. Glass.
  - 11. Concrete masonry units in utility, mechanical, and electrical spaces.
  - 12. Acoustical materials, unless specifically indicated.
  - 13. Concealed pipes, ducts, and conduits.

#### 1.2 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide complete list of products to be used, with the following information for each:
  - 1. MPI product number (e.g. MPI #47).
  - 2. Cross-reference to specified paint system(s) product is to be used in; include description of each system.
  - 3. Manufacturer's installation instructions.
  - 4. If proposal of substitutions is allowed under submittal procedures, explanation of substitutions proposed.

- C. Samples: Submit three paper "draw down" samples, 8-1/2 by 11 inches in size, illustrating range of colors available for each finishing product specified.
  - 1. Where sheen is specified, submit samples in only that sheen.
  - 2. Where sheen is not specified, submit each color in each sheen available.
  - 3. Where sheen is not specified, discuss sheen options with Architect before preparing samples, to eliminate sheens definitely not required.

### 1.3 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified, with minimum three years documented experience.

### 1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site in sealed and labeled containers; inspect to verify acceptability.
- B. Container Label: Include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.
- C. Paint Materials: Store at minimum ambient temperature of 45 degrees F and a maximum of 90 degrees F, in ventilated area, and as required by manufacturer's instructions.

### 1.5 FIELD CONDITIONS

- A. Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by the paint product manufacturer.
- B. Follow manufacturer's recommended procedures for producing best results, including testing of substrates, moisture in substrates, and humidity and temperature limitations.
- C. Do not apply materials when relative humidity exceeds 85 percent; at temperatures less than 5 degrees F above the dew point; or to damp or wet surfaces.
- D. Minimum Application Temperatures for Paints: 50 degrees F for interiors unless required otherwise by manufacturer's instructions.
- E. Provide lighting level of 80 ft candles measured mid-height at substrate surface.

## PART 2 PRODUCTS

### 2.1 MANUFACTURERS

- A. Provide paints and finishes used in any individual system from the same manufacturer; no exceptions.
- B. Paints:
  - 1. Behr Process Corporation: [www.behr.com/#sle](http://www.behr.com/#sle).
  - 2. PPG Paints: [www.ppgpaints.com/#sle](http://www.ppgpaints.com/#sle).
  - 3. Sherwin-Williams Company: [www.sherwin-williams.com/#sle](http://www.sherwin-williams.com/#sle).
- C. Primer Sealers: Same manufacturer as top coats.

## 2.2 PAINTS AND FINISHES - GENERAL

- A. Paints and Finishes: Ready mixed, unless intended to be a field-catalyzed paint.
  - 1. Where MPI paint numbers are specified, provide products listed in Master Painters Institute Approved Product List, current edition available at [www.paintinfo.com](http://www.paintinfo.com), for specified MPI categories, except as otherwise indicated.
  - 2. Provide materials that are compatible with one another and the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.
  - 3. For opaque finishes, tint each coat including primer coat and intermediate coats, one-half shade lighter than succeeding coat, with final finish coat as base color.
  - 4. Supply each paint material in quantity required to complete entire project's work from a single production run.
  - 5. Do not reduce, thin, or dilute paint or finishes or add materials unless such procedure is specifically described in manufacturer's product instructions.
- B. Volatile Organic Compound (VOC) Content:
  - 1. Provide paints and finishes that comply with the most stringent requirements specified in the following:
    - a. 40 CFR 59, Subpart D--National Volatile Organic Compound Emission Standards for Architectural Coatings.
    - b. Architectural coatings VOC limits of the State in which the Project is located.
- C. Flammability: Comply with applicable code for surface burning characteristics.
- D. Sheens: Provide the sheens specified; where sheen is not specified, sheen will be selected later by Architect from the manufacturer's full line.

## 2.3 PAINT SYSTEMS - INTERIOR

- A. Paint I-OP - Interior Surfaces to be Painted, Unless Otherwise Indicated: Including gypsum board, concrete, concrete masonry units, wood, uncoated steel, shop primed steel, galvanized steel, and aluminum.
  - 1. Two top coats and one coat primer.
  - 2. Top Coat(s): High Performance Architectural Interior Latex; MPI #138, 139, 140, or 141.
- B. Paint I-OP-MD-DT - Medium Duty Door/Trim: For surfaces subject to frequent contact by occupants, including metals and wood:
  - 1. Medium duty applications include doors, door frames, railings, handrails, guardrails, and balustrades.
  - 2. Two top coats and one coat primer.
  - 3. Top Coat(s): Interior Epoxy-Modified Latex; MPI #115 or 215.
    - a. Products:
      - 1) PPG Paints Pitt-Glaze WB Water-Borne Acrylic Epoxy, 16-598 Series, Semi-Gloss.
      - 2) PPG Paints Pitt-Glaze WB Water-Borne Acrylic Epoxy, 16-599 Series, Gloss.
      - 3) Sherwin-Williams Pro Industrial Waterbased Catalyzed Epoxy, Gloss. (MPI #115)
      - 4) Sherwin-Williams Waterbased Catalyzed Epoxy, Semi-Gloss.
      - 5) Sherwin-Williams Waterbased Catalyzed Epoxy, Gloss.



## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Do not begin application of paints and finishes until substrates have been properly prepared.
- B. Verify that surfaces are ready to receive work as instructed by the product manufacturer.
- C. Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially effect proper application.
- D. Test shop-applied primer for compatibility with subsequent cover materials.

### 3.2 PREPARATION

- A. Clean surfaces thoroughly and correct defects prior to application.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
- C. Remove or repair existing paints or finishes that exhibit surface defects.
- D. Remove or mask surface appurtenances, including electrical plates, hardware, light fixture trim, escutcheons, and fittings, prior to preparing surfaces or finishing.
- E. Seal surfaces that might cause bleed through or staining of topcoat.
- F. Remove mildew from impervious surfaces by scrubbing with solution of tetra-sodium phosphate and bleach. Rinse with clean water and allow surface to dry.
- G. Concrete:
  - 1. Remove release agents, curing compounds, efflorescence, and chalk. Do not coat surfaces if moisture content or alkalinity of surfaces to be coated exceeds that permitted in manufacturer's written instructions.
  - 2. Clean surfaces with pressurized water. Use pressure range of 1,500 to 4,000 psi at 6 to 12 inches. Allow to dry.
  - 3. Clean concrete according to ASTM D4258. Allow to dry.
  - 4. Prepare surface as recommended by top coat manufacturer and according to SSPC-SP 13.
- H. Gypsum Board: Fill minor defects with filler compound. Spot prime defects after repair.
- I. Insulated Coverings: Remove dirt, grease, and oil from canvas and cotton.
- J. Aluminum: Remove surface contamination and oils and wash with solvent according to SSPC-SP 1.
- K. Copper: Remove contamination by steam, high pressure water, or solvent washing.
- L. Galvanized Surfaces:
  - 1. Remove surface contamination and oils and wash with solvent according to SSPC-SP 1.
  - 2. Prepare surface according to SSPC-SP 2.

- M. Ferrous Metal:
  - 1. Solvent clean according to SSPC-SP 1.
  - 2. Shop-Primed Surfaces: Sand and scrape to remove loose primer and rust. Feather edges to make touch-up patches inconspicuous. Clean surfaces with solvent. Prime bare steel surfaces. Re-prime entire shop-primed item.
  - 3. Remove rust, loose mill scale, and other foreign substances using methods recommended in writing by paint manufacturer and blast cleaning according to SSPC-SP 6 "Commercial Blast Cleaning". Protect from corrosion until coated.
- N. Wood Doors to be Field-Finished: Seal wood door top and bottom edge surfaces with clear sealer.

### 3.3 APPLICATION

- A. Remove unfinished louvers, grilles, covers, and access panels on mechanical and electrical components and paint separately.
- B. Apply products in accordance with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual".
- C. Where adjacent sealant is to be painted, do not apply finish coats until sealant is applied.
- D. Do not apply finishes to surfaces that are not dry. Allow applied coats to dry before next coat is applied.
- E. Apply each coat to uniform appearance in thicknesses specified by manufacturer.
- F. Dark Colors and Deep Clear Colors: Regardless of number of coats specified, apply as many coats as necessary for complete hide.
- G. Sand wood and metal surfaces lightly between coats to achieve required finish.
- H. Vacuum clean surfaces of loose particles. Use tack cloth to remove dust and particles just prior to applying next coat.
- I. Wood to Receive Transparent Finishes: Tint fillers to match wood. Work fillers into the grain before set. Wipe excess from surface.
- J. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.

### 3.4 CLEANING

- A. Collect waste material that could constitute a fire hazard, place in closed metal containers, and remove daily from site.

### 3.5 PROTECTION

- A. Protect finishes until completion of project.
- B. Touch-up damaged finishes after Substantial Completion.

END OF SECTION

## SECTION 10 11 00 - VISUAL DISPLAY UNITS

### PART 1 GENERAL

#### 1.1 SECTION INCLUDES

- A. Glass markerboards.

#### 1.2 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's data on glass markerboard, trim, and accessories.
- C. Samples: Color charts for selection of color and texture of glass markerboard and trim.
- D. Maintenance Data: Include data on regular cleaning, and stain removal.

#### 1.3 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

#### 1.4 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B. Provide five year warranty for markerboard to include warranty against discoloration due to cleaning, crazing or cracking, and staining.

### PART 2 PRODUCTS

#### 2.1 VISUAL DISPLAY UNITS

- A. Magnetic Glass Markerboards:
  - 1. Manufacturers:
    - a. Claridge Products and Equipment, Inc: [www.claridgeproducts.com/#sle](http://www.claridgeproducts.com/#sle).
    - b. GGI - General Glass International: [www.generalglass.com/#sle](http://www.generalglass.com/#sle).
    - c. Ghent, a GMI Company: [www.ghent.com/#sle](http://www.ghent.com/#sle).
    - d. MooreCo, Inc: [www.moorecoinc.com/#sle](http://www.moorecoinc.com/#sle).
    - e. Bestrite is basis of design.
  - 2. Glass: Laminated, low iron, 1/4 inch thick, with bevel edges and radiused corners, laminated to steel backing sheet for use with magnets. Coated or treated for use as dry erase board or projection surface.
  - 3. Steel Backing Sheet Thickness: 24 gauge, 0.0239 inch .
  - 4. Size: As indicated on drawings.
  - 5. Frame: No frame, with concealed fasteners.
  - 6. Mounting: Concealed Z clips.
  - 7. Accessories: Provide magnetic marker tray and magnetic marker holder.

## 2.2 MATERIALS

- A. Float Glass: Provide float-glass-based glazing unless otherwise indicated.
  - 1. Fully Tempered Safety Glass: Comply with ANSI Z97.1 or 16 CFR 1201 criteria for safety glazing used in hazardous locations.
  - 2. Thickness: As indicated.
- B. Laminated Glass: Float glass laminated in accordance with ASTM C1172.
  - 1. Laminated Safety Glass: Comply with ANSI Z97.1 - Class B or 16 CFR 1201 - Category I impact test requirements.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that internal wall blocking is ready to receive work and positioning dimensions are as indicated on shop drawings.

### 3.2 PREPARATION

- A. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

### 3.3 INSTALLATION

- A. Install boards in accordance with manufacturer's instructions.
- B. Secure units level and plumb.
- C. Butt Joints: Install with tight hairline joints.

### 3.4 CLEANING

- A. Clean board surfaces in accordance with manufacturer's instructions.
- B. Remove temporary protective cover at Date of Substantial Completion.

END OF SECTION

## SECTION 10 21 13.13 - METAL TOILET COMPARTMENTS

### PART 1 GENERAL

#### 1.1 SECTION INCLUDES

- A. Metal toilet compartments.
- B. Urinal and Vestibule screens.

#### 1.2 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate the work with placement of support framing and anchors in walls and ceilings.

#### 1.3 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate partition plan, elevation views, dimensions, details of wall, floor, and ceiling supports, door swings.
- C. Product Data: Provide data on panel construction, hardware, and accessories.

### PART 2 PRODUCTS

#### 2.1 MANUFACTURERS

- A. Metal Toilet Compartments:
  - 1. All American Metal Corp - AAMCO: [www.allamericanmetal.com/#sle](http://www.allamericanmetal.com/#sle).
  - 2. ASI Accurate Partitions: [www.asi-accuratepartitions.com/#sle](http://www.asi-accuratepartitions.com/#sle).
  - 3. ASI Global Partitions: [www.asi-globalpartitions.com/#sle](http://www.asi-globalpartitions.com/#sle).
  - 4. General Partitions Mfg. Corp: [www.generalpartitions.com/#sle](http://www.generalpartitions.com/#sle).
  - 5. Hadrian: [www.hadrian-inc.com/#sle](http://www.hadrian-inc.com/#sle).
  - 6. Metpar Corp: [www.metpar.com/#sle](http://www.metpar.com/#sle).
  - 7. Monarch Toilet Partition Inc: [www.monarchpartition.com/#sle](http://www.monarchpartition.com/#sle).
  - 8. Partition Manufacturers of America, Inc: [www.partitioninc.com/#sle](http://www.partitioninc.com/#sle).
  - 9. Substitutions: Section 01 60 00 - Product Requirements.

#### 2.2 MATERIALS

- A. Steel Sheet: Hot-dipped galvanized steel sheet, ASTM A653/A653M, with G90/Z275 coating.

#### 2.3 COMPONENTS

- A. Toilet Compartments: Powder coated steel, ceiling-hung.
- B. Doors, Panels, and Pilasters: Sheet steel faces, pressure bonded to sound-deadening core, corners made with corner clips or mitered, welded, and ground smooth.
  - 1. Panel Faces: 22 gauge, 0.0299 inch.
  - 2. Door Faces: 22 gauge, 0.0299 inch.
  - 3. Pilaster Faces: 22 gauge, 0.0299 inch.
  - 4. Reinforcement: 12 gauge, 0.1046 inch.

5. Internal Reinforcement: Provide in areas of attached hardware and fittings. Mark locations of reinforcement for partition mounted washroom accessories.
- C. Door and Panel Dimensions:
  1. Thickness: 1 inch.
  2. Door Width: 24 inches.
  3. Height: 63-1/2 inches.
- D. Pilasters: 1-1/4 inch thick, of sizes required to suit compartment width and spacing.
- E. Urinal Screens: Wall mounted with two panel brackets, and floor-to-ceiling vertical upright consisting of pilaster anchored to floor and ceiling.

#### 2.4 ACCESSORIES

- A. Brackets: Polished chrome-plated non-ferrous cast metal.
- B. Attachments, Screws, and Bolts: Chrome-plated steel, tamper-proof type.
  1. For attaching panels and pilasters to brackets: Through-bolts and nuts ; tamper proof.
- C. Hardware: Polished chrome plated non-ferrous cast metal:
  1. Pivot hinges, gravity type, adjustable for door close positioning; two per door.
  2. Thumb turn or sliding door latch with exterior emergency access feature.
  3. Door strike and keeper with rubber bumper; mounted on pilaster in alignment with door latch.
  4. Coat hook with rubber bumper; one per compartment, mounted on door.
  5. Provide door pull for outswinging doors.

#### 2.5 FINISHING

- A. Powder-Coated Steel Compartments: Manufacturer's standard process. Clean, degrease, and neutralize.

### PART 3 EXECUTION

#### 3.1 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that field measurements are as indicated.
- C. Verify correct spacing of and between plumbing fixtures.
- D. Verify correct location of built-in framing, anchorage, and bracing.

#### 3.2 INSTALLATION

- A. Install partitions secure, rigid, plumb, and level in accordance with manufacturer's instructions.
- B. Maintain 3/8 to 1/2 inch space between wall and panels and between wall and end pilasters.
- C. Attach panel brackets securely to walls using anchor devices.
- D. Attach panels and pilasters to brackets.

- E. Field touch-up of scratches or damaged enamel finish will not be permitted. Replace damaged or scratched materials with new materials.

### 3.3 TOLERANCES

- A. Maximum Variation From True Position: 1/4 inch.
- B. Maximum Variation From Plumb: 1/8 inch.

### 3.4 ADJUSTING

- A. Adjust and align hardware to uniform clearance at vertical edge of doors, not exceeding 3/16 inch.
- B. Adjust hinges to position doors in partial opening position when unlatched. Return out swinging doors to closed position.
- C. Adjust adjacent components for consistency of line or plane.

END OF SECTION

## SECTION 10 28 00 - TOILET, BATH, AND LAUNDRY ACCESSORIES

### PART 1 GENERAL

#### 1.1 SECTION INCLUDES

- A. Commercial toilet accessories.
- B. Under-lavatory pipe supply covers.
- C. Utility room accessories.

### PART 2 PRODUCTS

#### 2.1 MATERIALS

- A. Accessories - General: Shop assembled, free of dents and scratches and packaged complete with anchors and fittings, steel anchor plates, adapters, and anchor components for installation.
  - 1. Grind welded joints smooth.
  - 2. Fabricate units made of metal sheet of seamless sheets with flat surfaces.
- B. Adhesive: Two component epoxy type, waterproof.
- C. Fasteners, Screws, and Bolts: Hot dip galvanized; tamper-proof; security type.
- D. Expansion Shields: Fiber, lead, or rubber as recommended by accessory manufacturer for component and substrate.

#### 2.2 FINISHES

- A. Stainless Steel: Satin finish, unless otherwise noted.

#### 2.3 COMMERCIAL TOILET ACCESSORIES

- A. Grab Bars: Stainless steel, smooth surface.
  - 1. Standard Duty Grab Bars:
    - a. Push/Pull Point Load: 250 pound-force, minimum.
    - b. Dimensions: 1-1/4 inch outside diameter, minimum 0.05 inch wall thickness, exposed flange mounting, 1-1/2 inch clearance between wall and inside of grab bar.
    - c. Finish: Satin.
    - d. Length and Configuration: As indicated on drawings.

#### 2.4 UNDER-LAVATORY PIPE AND SUPPLY COVERS

- A. Under-Lavatory Pipe and Supply Covers:
  - 1. Insulate exposed drainage piping, including hot, cold, and tempered water supplies under lavatories or sinks to comply with ADA Standards.
  - 2. Exterior Surfaces: Smooth non-absorbent, non-abrasive surfaces.
  - 3. Construction: 1/8 inch flexible PVC.
    - a. Surface Burning Characteristics: Flame spread index of 25 or less and smoke developed index of 450 or less, when tested in accordance with ASTM E84.
    - b. Comply with ASTM C1822, type indicated.



- c. Comply with ASME A112.18.9.
- d. Comply with ICC A117.1.
- e. Microbial and Fungal Resistance: Comply with ASTM G21.
- 4. Color: White.
- 5. Fasteners: Reusable, snap-locking fasteners with no sharp or abrasive external surfaces.
- 6. Products:
  - a. Plumberex Specialty Products, Inc; Plumberex Handy-Shield Maxx: [www.plumberex.com/#sle](http://www.plumberex.com/#sle).
  - b. Plumberex Specialty Products, Inc; Plumberex Trap Gear: [www.plumberex.com/#sle](http://www.plumberex.com/#sle).
  - c. Plumberex Specialty Products, Inc; Plumberex Pro-Extreme: [www.plumberex.com/#sle](http://www.plumberex.com/#sle).

### PART 3 EXECUTION

#### 3.1 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify exact location of accessories for installation.
- C. For electrically-operated accessories, verify that electrical power connections are ready and in the correct locations.
- D. Verify that field measurements are as indicated on drawings.

#### 3.2 PREPARATION

- A. Deliver inserts and rough-in frames to site for timely installation.
- B. Provide templates and rough-in measurements as required.

#### 3.3 INSTALLATION

- A. Install accessories in accordance with manufacturers' instructions in locations indicated on drawings.
- B. Install plumb and level, securely and rigidly anchored to substrate.
- C. Mounting Heights: As required by accessibility regulations, unless otherwise indicated.
  - 1. Grab Bars: As indicated on drawings.

#### 3.4 PROTECTION

- A. Protect installed accessories from damage due to subsequent construction operations.

END OF SECTION

## SECTION 10 44 00 - FIRE PROTECTION SPECIALTIES

### PART 1 GENERAL

#### 1.1 SECTION INCLUDES

- A. Fire extinguishers.
- B. Fire extinguisher cabinets.
- C. Accessories.

#### 1.2 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide extinguisher operational features.
- C. Manufacturer's Installation Instructions: Indicate special criteria and wall opening coordination requirements.

#### 1.3 FIELD CONDITIONS

- A. Do not install extinguishers when ambient temperature may cause freezing of extinguisher ingredients.

### PART 2 PRODUCTS

#### 2.1 MANUFACTURERS

- A. Fire Extinguishers:
  - 1. Activar Construction Products Group, Inc. - JL Industries; Cosmic Extinguisher - Multipurpose Chemical: [www.activarcpg.com/#sle](http://www.activarcpg.com/#sle).
  - 2. Kidde, a unit of United Technologies Corp: [www.kidde.com/#sle](http://www.kidde.com/#sle).
  - 3. Nystrom, Inc: [www.nystrom.com/#sle](http://www.nystrom.com/#sle).
  - 4. Oval Brand Fire Products; Oval Dry Chemical Fire Extinguisher - Multipurpose ABC: [www.ovalfireproducts.com/#sle](http://www.ovalfireproducts.com/#sle).
  - 5. Potter-Roemer; \_\_\_\_\_: [www.potterroemer.com/#sle](http://www.potterroemer.com/#sle).
  - 6. Pyro-Chem, a Tyco Business; \_\_\_\_\_: [www.pyrochem.com/#sle](http://www.pyrochem.com/#sle).
- B. Fire Extinguisher Cabinets and Accessories:
  - 1. Activar Construction Products Group, Inc. - JL Industries; Ambassador Series: [www.activarcpg.com/#sle](http://www.activarcpg.com/#sle).
  - 2. Kidde, a unit of United Technologies Corp: [www.kidde.com/#sle](http://www.kidde.com/#sle).
  - 3. Larsen's Manufacturing Co: [www.larsensmfg.com/#sle](http://www.larsensmfg.com/#sle).
  - 4. Nystrom, Inc: [www.nystrom.com/#sle](http://www.nystrom.com/#sle).

#### 2.2 FIRE EXTINGUISHERS

- A. Fire Extinguishers - General: Comply with product requirements of NFPA 10 and applicable codes, whichever is more stringent.
  - 1. Provide extinguishers labeled by UL (DIR) or FM (AG) for purpose specified and as indicated.

- B. Multipurpose Dry Chemical Type Fire Extinguishers: Carbon steel tank, with pressure gauge.
  - 1. Class: A:B:C type.
  - 2. Size: 20 pound.
  - 3. Finish: Red

### 2.3 FIRE EXTINGUISHER CABINETS

- A. Fire Rating: Listed and labeled in accordance with ASTM E814 requirements for fire resistance rating of walls where being installed.
- B. Cabinet Construction: Non-fire rated.
  - 1. Formed primed steel sheet; 0.036 inch thick base metal.
  - 2. Formed aluminum; \_\_\_\_ inch thick base metal.
- C. Cabinet Configuration: Recessed type.
  - 1. Size to accommodate accessories.
- D. Door: 0.036 inch metal thickness, reinforced for flatness and rigidity with nylon catch. Hinge doors for 180 degree opening with two butt hinges.
- E. Door Glazing: Acrylic plastic, clear, 1/8 inch thick, flat shape and set in resilient channel glazing gasket.
- F. Cabinet Mounting Hardware: Appropriate to cabinet, with pre-drilled holes for placement of anchors.
- G. Fabrication: Weld, fill, and grind components smooth.
- H. Finish of Cabinet Exterior Trim and Door: No.4 - Brushed stainless steel.
- I. Finish of Cabinet Interior: White colored enamel.

### 2.4 ACCESSORIES

- A. Extinguisher Brackets: Formed steel, chrome-plated.
- B. Lettering: "FIRE EXTINGUISHER" decal, or vinyl self-adhering, prespaced black lettering in accordance with authorities having jurisdiction (AHJ).

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify rough openings for cabinet are correctly sized and located.

### 3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install cabinets plumb and level in wall openings.

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231609

Fire Protection Specialties

SECTION 10 44 00

- C. Secure rigidly in place.
- D. Place extinguishers in cabinets.

END OF SECTION

## SECTION 12 36 00 - COUNTERTOPS

### PART 1 GENERAL

#### 1.1 SECTION INCLUDES

- A. Countertops for architectural cabinet work.
- B. Wall-hung counters and vanity tops.

#### 1.2 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Manufacturer's data sheets on each product to be used, including:
  - 1. Preparation instructions and recommendations.
  - 2. Storage and handling requirements and recommendations.
  - 3. Specimen warranty.
- C. Shop Drawings: Complete details of materials and installation ; combine with shop drawings of cabinets and casework specified in other sections.
- D. Selection Samples: For each finish product specified, color chips representing manufacturer's full range of available colors and patterns.

#### 1.3 QUALITY ASSURANCE

- A. Fabricator Qualifications: Natural Stone Institute (NSI) Accredited Natural Stone Fabricator; [www.naturalstoneinstitute.org/#sle](http://www.naturalstoneinstitute.org/#sle).
- B. Installer Qualifications: Company specializing in performing work of the type specified in this section, with not less than three years of documented experience.

#### 1.4 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

#### 1.5 FIELD CONDITIONS

- A. 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.

## PART 2 PRODUCTS

### 2.1 COUNTERTOPS

- A. Quality Standard: Custom Grade, in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), unless noted otherwise.

### 2.2 ACCESSORIES

- A. Fixed Top-Mounted Countertop Support Brackets:
  - 1. Material: Steel.
  - 2. Finish: Manufacturer's standard, factory-applied, textured powder coat.
  - 3. Color: Black.

### 2.3 FABRICATION

- A. Fabricate tops and splashes in the largest sections practicable, with top surface of joints flush.
  - 1. Join lengths of tops using best method recommended by manufacturer.
  - 2. Fabricate to overhang fronts and ends of cabinets 1 inch except where top butts against cabinet or wall.
    - a. Rout a 1/8 inch drip groove at underside of exposed overlapping edges, set back 1/2 inch from face of edge.
  - 3. Prepare all cutouts accurately to size; replace tops having improperly dimensioned or unnecessary cutouts or fixture holes.
- B. Provide back/end splash wherever counter edge abuts vertical surface unless otherwise indicated.
  - 1. Secure to countertop with concealed fasteners and with contact surfaces set in waterproof glue.
  - 2. Height: 4 inches, unless otherwise indicated.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
- C. Verify that wall surfaces have been finished and mechanical and electrical services and outlets are installed in proper locations.

### 3.2 PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

### 3.3 INSTALLATION

- A. Install vanities in accordance with manufacturer's instructions and approved shop drawings

- B. Securely attach countertops to cabinets using concealed fasteners. Make flat surfaces level; shim where required.
- C. Seal joint between back/end splashes and vertical surfaces.

#### 3.4 TOLERANCES

- A. Variation From Horizontal: 1/8 inch in 10 feet, maximum.
- B. Offset From Wall, Countertops: 1/8 inch maximum; 1/16 inch minimum.
- C. Field Joints: 1/8 inch wide, maximum.

#### 3.5 CLEANING

- A. Clean countertops surfaces thoroughly.

#### 3.6 PROTECTION

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

END OF SECTION

## SECTION 21 05 00 – GENERAL FIRE SUPPRESSION PROVISIONS

### 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 specifying the general requirements for execution of that portion of the Work defined in Division 21 of these Specifications and as indicated on the Drawings:
  - 1. Major items include, but are not necessarily limited to:
    - a. Cutting and patching.
    - b. Concrete foundations and support steel.
    - c. Piping, fittings and valves.
    - d. Excavation and backfilling required.
    - e. Fire protection systems.
    - f. Demolition of existing work.
    - g. Labor, materials, equipment, tools, supervision, and start-up services.
    - h. Instructions to Owner regarding operation.
    - i. Incidental and related items necessary to a complete and functionally operational installation of the Work.
- B. Division of Work: In accordance with the General Conditions, Contractor is responsible for dividing the Work among the Subcontractors and Suppliers and for delineating the Work to be performed by specific trades. The following are suggestions as to how the Work may be divided. This is not a complete list of all the Work:
  - 1. General Contractor:
    - a. Install access doors.
    - b. Provide concrete isolation and housekeeping pads for fire suppression equipment.
    - c. Refer to Division 01 Section "Cutting and Patching."
    - d. Provide access doors in walls and ceilings for access to fire suppression equipment.
  - 2. Fire Suppression Subcontractor:
    - a. Refer to Division 01 Section "Cutting and Patching."
    - b. Furnish location, size, and quantity of openings to Contractor before construction of new walls, ceilings, and floors.
    - c. Furnish size and locations of concrete equipment isolation and housekeeping pads as required for this Work and as indicated on the Drawings to Contractor before slabs are poured.
    - d. Furnish size and location of access doors required for this work as indicated on the Drawings to Contractor.
    - e. Provide excavation and backfilling required in connection with the Work of Division 21.
    - f. Provide miscellaneous structural steel required in connection with support of the Work of Division 21.
    - g. Perform final cleaning of fire suppression systems and equipment.

#### 1.3 REFERENCES

- A. Except as herein specified or as indicated on the Drawings, the work of Division 21 shall comply with the following:
  - 1. ANSI: A13.1 - Standard for the Identification of Piping Systems.
  - 2. ASME - American Society of Mechanical Engineers: B31.9 - Building Services Piping.
  - 3. ASTM: A325 - Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
  - 4. Michigan Building Code of 2015.
  - 5. NFPA Standards:
    - a. 13 – Installation of Sprinkler Systems.
    - b. 24 – Installation of Private Fire Service Mains and their Appurtenances.
    - c. 25 – Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.
    - d. 45 - Fire Protection for Laboratories Using Chemicals.



- e. 230 – Fire Protection of Storage.
- f. 1963 – Standard for Fire Hose Connections.
- 6. UL:
  - a. 193 – Alarm Valves for Fire Protection Service.
  - b. 260 – Standard for Safety for Dry Pipe and Deluge Valves for Fire Protection Service.
  - c. 262 – Gate Valves for Fire Protection Service.
  - d. 312 – Check Valves for Fire Protection Service.
  - e. 668 – Hose Valves for Fire Protection Service.
  - f. 753 – Alarm Accessories for Automatic Water-Supply Control Valves for Fire Protection Service.
  - g. 789 – Indicator Posts for Fire Protection Services.
- 7. Additional References: Factory Mutual Research Corporation (FM).

#### 1.4 DESIGN AND PERFORMANCE REQUIREMENTS

- A. System layout and design responsibility are included as Work of this Section:
  - 1. Details of construction, quantities, components, and accessories indicated on the Drawings and in the specifications are minimum requirements.
  - 2. Minimum design criteria are as specified herein and as indicated on the Drawings.
  - 3. Confirm final design requirements with the authority or authorities having jurisdiction and the Owner's insuring agency.
  - 4. Increases in system component requirements beyond these minimums that are determined by the system designer to be necessary to provide the functional intent and for a complete system shall not be a basis for increase in cost to Owner.
  - 5. Final Design:
    - a. The equipment and piping sizes and selections, where indicated on the Drawings, are minimum requirements and have been determined through the application of good engineering practice and standard calculation methods based on the best information available at the time that these documents were produced. A complete layout and hydraulic analysis has not been done.
    - b. It is the responsibility of Contractor to verify all assumptions and design elements used as the basis of the preliminary design and to perform final calculations, sizing and selections as necessary to comply with the performance criteria specified herein and NFPA 13.
- B. Construction details, components, accessories, sizes and model numbers indicated on the Drawings or in these specifications are used to indicate minimum levels of quality and coordination requirements.
- C. Equipment supplied, whether as scheduled or selected from list of acceptable Manufacturers, must meet minimum requirements listed in specifications or on Drawings, be compatible with facility and intended use, and meet requirements for a functional system.
- D. Drawings:
  - 1. Are diagrammatic and indicate general arrangement of systems and work included.
  - 2. Do not necessarily indicate every required valve, fitting, trap, thermometer, gage, duct, elbow, transition, turning vane, mounting support and access panel.
  - 3. Shall not be scaled for measurement or installation location.
  - 4. Shall not serve as Shop Drawings.
- E. Schedules and model numbers shall not be used to:
  - 1. Serve as final, definitive quantity requirements. Contractor shall make own count as indicated on Drawings.
  - 2. Determine proper type or model with arrangement, mounting and accessories applicable.
- F. Coordinate installation work of Division 21 with work of other trades to provide a complete and functional system. Generally, the location of ductwork, sanitary, storm and vent piping take precedence over fire protection and HVAC piping, electrical conduit and cable trays.

#### 1.5 PRODUCT UNLOADING AND HANDLING

- A. Unload equipment and materials required for completion of the Work.

- B. Handle and store equipment and materials carefully to prevent damage. Method of rigging and handling shall be subject to the approval of an authorized representative of the equipment Manufacturer whose equipment is being handled.

#### 1.6 MAINTENANCE

- A. Special Tools: Where special tools are required for operation, furnish these to Owner.
- B. Loose and Detachable Parts:
  - 1. Retain loose and small detachable parts of the apparatus and equipment furnished until the completion of the Work.
  - 2. Turn over these parts to Owner.
- C. Construction Strainers:
  - 1. Remove after flushing and cleaning and prior to commencement of TAB.
  - 2. Attach removed construction strainer to piping where removed as proof of removal.

### PART 2 - PRODUCTS

#### 2.1 FABRICATIONS

- A. Miscellaneous Structural Steel:
  - 1. Comply with the requirements of Division 05 Section "Metal Fabrications," where applicable.
  - 2. Structural steel work shall be done in accordance with the AISC Specification for Design, Fabrication and Erection of Structural Steel for Buildings, except that allowable stresses shall be reduced 25%.
  - 3. Where required, high strength structural steel bolting conforming to ASTM Specification A325 and assembled to AISC "Specifications for Assembly of Structural Joints. Using High Strength Steel Bolts" or welding shall be used in place of rivets.
  - 4. Connections shall be properly designed for the type of connection and the loads to be carried, and shall be subject to Engineer's or Owner's approval.
  - 5. Welding shall be done by operators who have been previously qualified by tests as prescribed in the American Welding Society "Standard Qualification Procedure" to perform the type of work required.
  - 6. Welding techniques shall conform to the American Welding Society "Code for Arc and Gas Welding in Building Construction", Section 4, Workmanship.
  - 7. Finished members shall be true to line and free from twist, bends and open joints.
- B. Material installed in a ceiling plenum shall be either noncombustible or have a maximum flame spread of 25 and a maximum smoke developed rating of 50.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Character of Work: Installation shall be executed in a workmanlike manner and shall present a neat mechanical appearance when completed.
- B. Laying Out of Work:
  - 1. Layout piping, equipment, and components in accordance with the Contract Documents and the Manufacturer's recommended practice, including provision of adequate space for maintenance. Review layout with Engineer prior to installation.
  - 2. Check drawings of other trades to verify spaces in which work will be installed. Maintain maximum head room and space conditions at all points. Where head room or space conditions appear inadequate, notify Engineer before proceeding with installation.
  - 3. If directed by Engineer, Contractor shall make reasonable modifications in the layout as required to permit proper execution of the Work and to prevent conflict with work of other trades.
  - 4. Work shall be installed so as to be ready for operation, maintenance and repair. Minor deviations from Drawings may be made to accomplish this. Changes shall not be made without approval of Engineer.

### 3.2 EXCAVATING AND BACKFILLING

- A. Backfill shall be MDOT Class II sand backfill. The use of clay, stone, rocks, brickbats, cinders, or frozen sand for backfill will not be permitted.
- B. Backfill and fill below structures and pavements shall be compacted to 95% density as determined by ASTM modified proctor.
- C. Pipe Bedding Material Shall:
  - 1. Conform with Manufacturer's recommendations.
  - 2. Be MDOT Class II modified to maximum size of 3/8 inches and compacted to 95% density as determined by ASTM modified proctor; or pea gravel with best compaction possible to provide firm continuous support.
  - 3. Run full width of trench from minimum 4 inches below pipe to 12 inches above pipe.

### 3.3 MODIFICATIONS TO EXISTING FACILITIES

- A. Prior to making connections to existing piping for reuse, confirm that existing piping being tied into is active for reuse.
- B. Comply with the requirements of Division 02 Section "Selective Demolition," for all work related to the modification, alteration, conversion, renovation, and reuse of existing facilities.

### 3.4 PIPE FITTINGS

- A. Provide insulating couplings or unions where dissimilar materials are joined.
- B. Provide unions at valves and at equipment for making repairs.

### 3.5 PAINTING

- A. Paint exposed, non-insulated piping in accordance with the requirements of Division 09 – Finishes.
- B. Provide labels as specified below. Comply with OSHA "Safety Color Code for Marking Physical Hazards" and ANSI A13.1 for pipe labels and colors.
- C. Valves, Fittings, and Supports:
  - 1. Paint valves and fittings the same base color as the pipe they adjoin.
  - 2. Paint floor stands the same base color as the pipe they adjoin.
  - 3. Paint wall brackets and pipe hangers the same base color as the wall or ceiling they adjoin, or gray, if wall or ceiling is not painted.

### 3.6 CODING AND TAGGING

- A. Piping:
  - 1. Applied to new piping after installation, insulation, and final painting.
  - 2. Conform to Owner's existing standards or conventions.
  - 3. Markings:
    - a. Painted on, 1-inch high black letters.
    - b. Color coded band, conforming to ANSI A13.1.
    - c. Directional arrow.
  - 4. Place markers at 20-foot centers with at least 1 in each room, and at each change in direction.
  - 5. Plastic coated "Set Mark-Snap-Around" pipe markers manufactured by Seton Name Plate Corp., New Haven, Connecticut; or approved equal, may be used in lieu of painted markers and bands.

- B. Valves:
  - 1. Provide brass or minimum 1/16-inch thick laminated plastic tags indicating assigned valve number on valves.
  - 2. Furnish schedule(s) of tagged valves with number, location and purpose of each valve.
  - 3. Place a copy of each schedule:
    - a. In the Maintenance Instructions.
    - b. In a string tie envelope labeled "Valve Schedule" and mount on the wall in Mechanical Room.
- C. Where valves are located above the ceilings, a cadmium plated screw or such marking as designed by Engineer shall be located in the ceiling tile directly below the device.
- D. Equipment:
  - 1. Provide for:
    - a. Labeled with its tag name/number as given on the Drawings.
    - b. Use 2-inch high stenciled painted lettering.
  - 2. Similarly label control components associated with the above named equipment items.

### 3.7 START-UP

- A. Comply with the requirements of Division 01 Section "Starting and Adjusting."

### 3.8 ADJUSTING

- A. Adjust and align equipment for smooth operation:
  - 1. Plumb true and with parts in proper position and alignment.
  - 2. Rotating parts shall turn freely and in the correct direction.
  - 3. Flexible couplings shall be checked for alignment subject to Owner's approval.
  - 4. Follow Manufacturer's instructions.
- B. The work of installation shall be executed in conformity with the best practice, so as to contribute to efficiency of operation, minimum noise or vibration, minimum maintenance, accessibility and sightlines.

### 3.9 FIELD QUALITY CONTROL

- A. Manufacturer's Field Services:
  - 1. Provide when required by individual Section.
  - 2. Provide the following services except where indicated otherwise in individual Sections:
    - a. Inspect, check and approve system installation.
    - b. Supervise system start-up.
    - c. Provide written report indicating that system:
      - 1) Has been properly installed and lubricated.
      - 2) Is in accurate alignment.
      - 3) Is free from undue stress imposed by connecting lines or anchor bolts.
      - 4) Has been satisfactorily operated under full load conditions.
    - d. Demonstrate operation of system to Owner's personnel.
    - e. Instruct Owner's personnel on operation and maintenance of system.
- B. Comply with the requirements of Division 01 Section "Starting and Adjusting."

### 3.10 CLEANING AND FINISHING

- A. Comply with the requirements of Division 01 Section "Cleaning and Waste Management."
- B. Entire installation shall be free from surface oil and grease before work will be considered for final payment.
- C. After tests have been made and the system pronounced tight:
  - 1. Clean piping and equipment.
  - 2. Lubricate bearings.

- D. Final cleaning includes but is not limited to the following:
  - 1. Equipment with Factory Finishes:
    - a. Wash factory-finished equipment with mild soap and water and leave in first-class condition, entirely free of stains or streaks.
    - b. Do not use abrasive materials. Touch up scratches or other violations of the factory finish paint with matching paint from the equipment Manufacturer prior to cleaning.

END OF SECTION 21 05 00

## SECTION 21 05 03 – STEEL PIPE AND FITTINGS FOR FIRE SUPPRESSION

### 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 furnishing and installation of steel pipe and fittings.
- B. Division of Work: In accordance with the General Conditions, Contractor is responsible for dividing the Work among the Subcontractors and Suppliers and for delineating the work to be performed by specific trades. The following are suggestions as to how the Work may be divided. This is not a complete list of all the work:
  - 1. General Contractor: Coordinate work of this Section with other trades.
  - 2. Mechanical Subcontractor: All work of this Section except as listed under General Contractor.

#### 1.3 REFERENCES

- A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with the following:
  - 1. ANSI/ASME Standards:
    - a. B16.1 – Cast Iron Pipe Flanges and Flanged Fittings.
    - b. B16.3 - Malleable Iron Threaded Fittings, Class 150 and 300.
    - c. B16.4 - Cast-Iron Threaded Fittings, Class 125 and 250.
    - d. B16.5 - Steel Pipe Flanges and Flanged Fittings.
    - e. B16.9 - Factory-Made Wrought Steel Buttwelding Fittings.
    - f. B16.11 - Forged Steel Fittings, Socket Welding and Threaded.
    - g. B16.21 - Nonmetallic Flat Gasket for Pipe Flanges.
    - h. B16.25 - Buttwelding Ends for Pipe, Valves, Flanges, and Fittings.
    - i. B18.2.1 - Square and Hex Bolts and Screws, Inch Series.
    - j. B18.2.2 - Square and Hex Nuts.
    - k. B31.1 - Power Piping.
    - l. B31.9 - Building Services Piping.
    - m. B36.10M - Wrought Steel Pipe.
  - 2. American Society of Mechanical Engineers (ASME) publications:
    - a. Boiler and Pressure Vessel Code.
    - b. Power Boiler Code.
    - c. Heating Boiler Code.
  - 3. ASTM Standards:
    - a. A53 - Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
    - b. A105 - Forgings, Carbon Steel, for Piping Components.
    - c. A106 - Seamless Carbon Steel Pipe for High-Temperature Service.
    - d. A126 - Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
    - e. A135 – Specification for Electric-Resistance-Welded Steel Pipe.
    - f. A181 - Forgings, Carbon Steel for General Purpose Piping.
    - g. A182 - Forged or Rolled Alloy Steel Pipe Flanges, Forged Fittings and Valves for High Temperature Service.
    - h. A193 - Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.
    - i. A194 - Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service.
    - j. A197 - Cupola Malleable Iron.
    - k. A234 - Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
    - l. A269 - Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
    - m. A307 - Carbon Steel Bolts and Studs, 60,000 psi Tensile.
    - n. A312 - Seamless and Welded Austenitic Stainless Steel Pipe.

- o. A395 - Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
- p. A795 - Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use.

#### 1.4 SUBMITTALS

- A. Submit Shop Drawings and Manufacturer's Literature: For steel pipe and fittings. Include Manufacturer name, Manufacturer location, dimensions, and details of construction and installation.

#### 1.5 QUALITY ASSURANCE

- A. Fabrication and Installation Personnel Qualifications:
  - 1. Trained and experienced in the fabrication and installation of the materials and equipment.
  - 2. Knowledgeable of the design and the reviewed Shop Drawings.
- B. Labeling: Piping materials shall bear the label, stamp or other marking of all specified standards and testing compliance.

### PART 2 - PRODUCTS

#### 2.1 MATERIALS

- A. General:
  - 1. Except as herein specified or as indicated on the Drawings, all materials shall be in accordance with the Piping Systems Schedule in Part 3 of the appropriate applicable specification section.
  - 2. Pipe 6'-0" and longer shall be permanently marked with the following information:
    - a. Manufacturer's name.
    - b. Pressure rating.
    - c. Size.
  - 3. All pipe joints shall be welded or grooved for pipe sizes 2-1/2 inches and larger.
- B. Black Steel Pipe:
  - 1. Black steel pipe shall be welded or seamless carbon steel, as specified for the type of service.
  - 2. Welded black steel pipe shall meet the requirements of ASTM A53 or A106, and shall be Type F continuous-weld furnace butt-welding (CW), or Type E electric resistance welded (ERW) Grade B.
  - 3. Seamless black steel pipe shall meet the requirements of ASTM A53 or A106, Type S seamless, Grade A or B.
- C. Buried Piping:
  - 1. Wrap with a pressure sensitive, adhesive backed, polyvinyl chloride or polyethylene tape:
    - a. Spirally wrap straight pipe with 0.020-inch thick tape with minimum overlap of 1/2-inch.
    - b. Spirally wrap 2 layers of 0.010 thick tape with minimum overlap of 1/2-inch.
    - c. Manufacturers: 3M Company "Scotchwrap"; or approved equal.
  - 2. Steel pipe with a factory applied polyethylene plastic coating such as Energy Coatings Company, "Pritec" may be used in lieu of wrapping specified above.

#### 2.2 FITTINGS

- A. Unless specifically noted otherwise, all fittings shall be of the same material or finish material as the pipe in which they are used.
  - 1. Cast iron or ductile iron fittings used on galvanized steel pipe shall be galvanized.
- B. Unions:
  - 1. Pipe Sizes 2 Inches and Smaller :
    - a. Forged steel with ground joint.
    - b. Properly fitted for design temperature and pressure.
    - c. 2000 pound rated equal to Crane No. 250H or 251H.
    - d. 3000 pound rated equal to Crane No. 252H.
  - 2. Pipe Sizes 2-1/2 Inches and Greater: Use companion flanges where unions are required.

- C. Tapped Bosses:
  - 1. Permitted in pipes and fittings.
  - 2. 1-1/2-inch maximum hole size.
  - 3. Boss Construction:
    - a. Weld material built up to a thickness 50% greater than required threads.
    - b. Forged bosses as approved by Engineer.
    - c. 300 pound rated half couplings welded to pipe permitted for instrument connections 3/4-inch or smaller.
  
- D. Screwed Fittings:
  - 1. Cast Class 300 iron in accordance with ASME B16.4.
  - 2. Ductile iron in accordance with ASTM A395.
  
- E. Welding Fittings:
  - 1. Meet ASTM A234 symbol WPA or WPB.
  - 2. The A or B grade shall conform to the grade of pipe used with the fittings.
  - 3. Dimensional standards shall conform to ASME B16.9.
  
- F. Flanges:
  - 1. General:
    - a. Welding neck or slip-on type with raised face.
    - b. Conforming to ANSI B16.5.
    - c. Class 150 and 300 conforming to ASTM A181, Grade I.
    - d. Class 600 and 900 conforming to ASTM A105, Grade II.
  - 2. Use threaded or socket weld type for piping smaller than 2-1/2 inches.
  - 3. Use flat face steel flanges when matching cast iron companion flanges.
  
- G. Flange Gaskets:
  - 1. Nonasbestos compressed material conforming to ASME B16.21 and suitable for 600 degrees F service.
  - 2. Ring type, 1/16-inch thickness.
  - 3. Spiral wound stainless steel for service over 300 psi.
  - 4. Use full face gaskets with flat face flanges.
  
- H. Bolting Material:
  - 1. General:
    - a. Carbon steel, square-head bolts and Grade 2H hex nuts.
    - b. Bolt length shall be sufficient to extend completely through nut with maximum 3/8-inch projection.
    - c. Dimensions conforming to ASME B18.2 (bolts) and ASTM A194 (nuts).
  - 2. Bolts:
    - a. For service below 250 psig/450 degrees F, use Grade B conforming to ASTM A307.
    - b. For service at or above 250 psig/450 degrees F, use Grade B7 conforming to ASTM A193.
  
- I. Socket Welding Fittings: All forged steel socket-welding fittings shall conform to ASME Standard B16.11 ASTM A105 Gr. II, equal to Crane 3,000-pound forged fittings.

## 2.3 GROOVED COUPLING SYSTEMS

- A. Manufacturers:
  - 1. Anvil.
  - 2. Victaulic.
  
- B. General:
  - 1. All grooved piping materials shall conform with the specifications governing the systems or application for which they are used.
  - 2. All couplings and fittings shall be finished with hot-dip galvanizing or alkyd enamel paint, unless copper.



- C. Pipe and Tubing:
  - 1. Standard Weight Steel Pipe:
    - a. Comply with the requirements of this Section.
    - b. ASTM Schedule 40, A53 black steel or hot-dipped zinc-coated and seamless.
- D. Couplings:
  - 1. Housing:
    - a. Standard Weight Steel Pipe: Ductile iron, ASTM A536.
      - 1) Galvanized when used on galvanized steel pipe.
  - 2. Style:
    - a. Standard Weight Steel Pipe:
      - 1) Rigid style.
      - 2) Victaulic "Zero-Flex" style 07; Grinnell style 577.
      - 3) Victaulic "Installation Ready" "FireLock" EZ Style 009N UL, FM and 107N UL.
  - 3. Gasket:
    - a. Water Service: EDPM.
    - b. Chemical Service: VITON.
    - c. Oil, Air Vacuum Service: Nitrile.
  - 4. Bolts – Nuts:
    - a. Track bolts with 110,000 psi tensile strength.
    - b. Heavy hex nuts.
    - c. Zinc electroplated carbon steel.
- E. Fittings:
  - 1. Steel, ductile iron.
  - 2. Grooves or shoulders compatible with system couplings.
  - 3. Victaulic "Installation Ready" fittings.
    - a. Groove: IGS "Innovative Groove System. Victaulic RG2100, with IGS Confirmation Gauge. System shall be UL listed for a working pressure of 300 psi, and FM approved for working pressure of 365 psi.
  - 4. Segmentally welded fittings not acceptable.
  - 5. Clamp-on mechanical not acceptable.
- F. Valves:
  - 1. Refer to Division 21 Section "Water Based Fire Suppression Systems" or specification section governing the system or application for which they are used.
  - 2. Compatible with grooved pipe coupling.
- G. Strainers:
  - 1. Refer to Division 21 Section "Water Based Fire Suppression Systems."
  - 2. Compatible with grooved pipe coupling.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. During Freezing Weather:
  - 1. Protect all materials in such a manner that no harm can be done to:
    - a. Installations already made.
    - b. Materials and equipment on the Site.
  - 2. Furnish all necessary protection for such installations and equipment as may be required.

### 3.2 ERECTION

- A. General:
  - 1. All Piping: Follow approved paths as indicated on the Drawings.
  - 2. Connect to existing lines where required, or to equipment in an approved manner.
  - 3. Locate Pipes, Valves and Equipment to Provide:
    - a. Access for maintenance.
    - b. Minimum obstruction of passageways and working space.

4. Normally, all pipe runs shall be plumb, parallel with the building and level, except for drain slope.
  5. Be responsible for establishing and maintaining drain slope of piping in order to ensure drainage.
  6. Expansion of Piping:
    - a. All pipe connections shall provide freedom of movement of the piping during expansion and contraction without springing of piping or injury to building steel or structure.
    - b. Any damage to building steel or structure as a result of work installed by Contractor shall be repaired at Contractor's expense.
  7. As Piping Material is Erected:
    - a. Thoroughly clean the inside of all piping.
    - b. Remove foreign material such as scale, sand, weld spatter, particles and cutting chips.
  8. Provide caps or plugs in all openings at the end of each day's work and as otherwise directed for the protection of the piping. Particular attention must be given to avoid the possibility of any foreign material entering the pipes.
  9. Flanges shall be made on pipe so that the gasket surface forms an angle of 90 degrees with the pipe axis. Screwed flanges shall be made on until the pipe projects through the flanges and then the flanges must be refaced.
- B. Sleeves and Holes:
1. Contractor shall be responsible for cutting required holes and openings in floors, walls and other structures, except as noted on the Drawings. Sleeves will be placed by Contractor in all such openings, and no holes shall be cut without Owner's approval. Sleeves shall be in accordance with the standard details included in the Drawings.
  2. All holes in floors, walls, roofs, etc., where pipe lines or other materials have been removed or installed, shall be neatly and properly filled with concrete, brick or other material in accordance with the general character of the construction at the location.
- C. Unions and Eccentric Fittings:
1. Screwed unions shall not be used on pipe sizes larger than 2-inches.
  2. Unions shall be provided at each screwed valve and where their use will facilitate dismantling of the piping and as required or directed in special cases.
  3. Eccentric fittings or eccentric reducing couplings shall be provided in all cases where air or water pockets would otherwise occur in the main due to the reduction in pipe size.
  4. All reducing fittings used at pump inlets shall be eccentric, flush on bottom.
- D. Pipe Joints:
1. Pipe connections at all valves shall be mechanically joined unless otherwise indicated on the Drawings or reviewed by Owner or Engineer.
  2. Pipe joints which will be buried or otherwise concealed shall be welded regardless of size.
  3. Mitered joints shall not be permitted.
  4. In general, black steel 2-1/2-inch and larger shall be welded except that a flange or union shall be provided at all valves and at equipment.
  5. The connections to welded 2-1/2-inch and larger pipe shall be made with a welding tee or Weld-o-let of butt, or socket type as required. Scarf welding of side connections shall not be permitted.
  6. Only welding ells shall be used for changing pipe directions of welded pipe lines.
- E. Pipe Welding:
1. Where welding is called for, it shall be of the fusion process and shall consist of welding by means of either the oxyacetylene or electric arc process.
  2. All welding shall conform to the ASME Boiler and Pressure Vessel Code or the ANSI Code for Pressure Piping. All welders shall be qualified in accordance with ASME Standard Qualifications for Welding Procedures, Welders and Welding Operators, or Section 9 of the ASME Boiler and Pressure Vessel Code for the class of piping being welded. Submit welding qualifications for all welders on the Project when requested by Engineer.
- ### 3.3 GROOVED SYSTEMS
- A. Piping shall be prepared in accordance with the latest Manufacturer's specifications or other standards applicable.
- B. Standard weight (Schedule 40 or heavier) steel piping may be roll grooved or cut grooved.

- C. Couplings, fittings, valves and pipe shall be assembled in accordance with latest Manufacturer's instructions.
- D. Cutting, Grooving and Crimping:
  - 1. All flexible pipe fittings including grooved, cut and plain end and all quick fittings shall be installed with a machine specifically designed for this purpose.
  - 2. All piping to be grooved, cut and crimped shall be prepared using this specifically designed machine.
- E. Mechanical joints are not allowed within walls.
- F. Manufacturer's Field Service: Arrange and pay for Manufacturer's engineer to provide the installation direction for a minimum onsite time of 1 day.
- G. Submit written approval of installation.

END OF SECTION 21 05 03

## SECTION 21 05 09 – COPPER PIPE AND FITTINGS FOR FIRE SUPPRESSION

### 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 furnishing and installation of copper pipe and fittings.
- B. Division of Work: In accordance with the General Conditions, Contractor is responsible for dividing the Work among the Subcontractors and Suppliers and for delineating the work to be performed by specific trades. The following are suggestions as to how the Work may be divided. This is not a complete list of all the work:
  - 1. General Contractor: Coordinate work of this Section with other trades.
  - 2. Mechanical Subcontractor: All work of this Section except as listed under General Contractor.

#### 1.3 REFERENCES

- A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with the following:
  - 1. ASTM Specifications: B88 - Seamless Copper Water Tube.
  - 2. ANSI Publications: A13.1 - Scheme for the Identification of Piping Systems.

#### 1.4 SUBMITTALS

- A. Shop Drawings and Manufacturer's Literature : Include dimensions, details of construction and installation, name of Manufacturer, model.

#### 1.5 QUALITY ASSURANCE

- A. Fabrication and Installation Personnel Qualifications:
  - 1. Trained and experienced in the fabrication and installation of the materials and equipment.
  - 2. Knowledgeable of the design and the reviewed Shop Drawings.

#### 1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials in original, unbroken, brand marked containers or wrapping as applicable.
- B. Handle and store materials in a manner which will prevent deterioration and contamination with foreign matter.
- C. Reject damaged, deteriorated or contaminated material and immediately remove from the Site. Replace removed materials at no additional cost to Owner.

### PART 2 - PRODUCTS

#### 2.1 PIPING MATERIALS

- A. Seamless Copper Tubing:
  - 1. Factory coded and marked.
  - 2. Conform to the following schedule:
    - a. Aboveground: ASTM B88, Type L or K, hard drawn.
    - b. Buried: ASTM B88, Type K annealed temper.

3. Pipe Markings:
  - a. All piping longer than 2'-0" shall have a permanent marking in accordance with ASTM or ANSI specifications.
  - b. This identification shall include the following:
    - 1) Manufacturer's name.
    - 2) Pipe pressure rating.
    - 3) Pipe size.
- B. Solder type shall conform to the following:
  1. Lines smaller than 2 inches: 95% tin, bismuth, copper and 5% silver.
  2. Lines 2 inches and larger: Silver Braze.

## 2.2 FITTINGS

- A. General Service:
  1. Sweat type, wrought copper, long radius elbows.
  2. Cast fittings shall only be allowed with written permission from the Engineer.

## 2.3 GROOVED COUPLING SYSTEMS

- A. Manufacturers:
  1. Victaulic.
- B. Materials:
  1. General:
    - a. All grooved piping materials shall conform with specifications governing the systems or application for which they are used.
    - b. All couplings and fittings shall be copper.
  2. Pipe and Tubing: Comply with the requirements of this Section.
  3. Couplings:
    - a. Housing: Ductile iron, ASTM A536.
    - b. Style:
      - 1) Rigid style.
      - 2) Victaulic style 606.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. During Freezing Weather:
  1. Protect all materials in such a manner that no harm can be done to:
    - a. Installations already made.
    - b. Materials and equipment on the Site.
  2. Furnish all necessary protection for such installations and equipment as may be required.

### 3.2 ERECTION

- A. General:
  1. All Piping: Follow approved paths as indicated on the Drawings.
  2. Connect to existing lines where required, or to equipment in an approved manner.
  3. Locate Pipes, Valves and Equipment to Provide:
    - a. Access for maintenance.
    - b. Minimum obstruction of passageways and working space.
  4. Normally, all pipe runs shall be plumb, parallel with the building and level, except for drain slope.
  5. Be responsible for establishing and maintaining drain slope of piping to ensure drainage.
  6. Expansion of Piping:
    - a. All pipe connections shall provide freedom of movement of the piping during expansion and contraction without springing of piping or injury to building steel or structure.

- b. Any damage to building steel or structure as a result of work installed by Contractor shall be repaired at Contractor's expense.
  - 7. As Piping Material is Erected:
    - a. Thoroughly clean the inside of all piping.
    - b. Remove foreign material such as scale, sand, weld spatter, particles and cutting chips.
  - 8. Provide caps or plugs in all openings at the end of each day's work and as otherwise directed for the protection of the piping.
- B. Pipe Joints:
  - 1. Cut ends of copper tubing squarely using only sharp tube cutters.
  - 2. Ream pipe to full I.D. before preparing the joint.
  - 3. Soldering:
    - a. Solder or braze joints by cleaning outside ends of all copper tubings and inside of fittings immediately before joining and soldering.
    - b. Apply solder flux to both tube and fitting.
    - c. Insert tube full depth into fitting, apply heat and solder in such a manner as to draw solder into and completely around the joint.
  - 4. Joining Valves:
    - a. When joining copper lines to valves follow Manufacturer's instructions.
    - b. In general:
      - 1) Valve shall be in the fully open position.
      - 2) Solenoid and expansion valves shall be broken down.

### 3.3 GROOVED COUPLING SYSTEMS

- A. Piping shall be prepared in accordance with the latest Manufacturer's specifications or other standards applicable.
- B. Copper tubing shall be roll grooved without metal removal.
- C. Couplings, fitting, valves and pipe shall be assembled in accordance with latest Manufacturer's instructions.
- D. Support piping according to Manufacturer's maximums span recommendations or Division 21 Section "Hangers and Supports for Fire Suppression Piping and Equipment," whichever is more stringent.
- E. Cutting, Grooving and Crimping:
  - 1. All flexible pipe fittings including grooved and plain end and all quick fit fittings shall be installed with a machine specifically designed for this purpose.
  - 2. All piping to be grooved, cut and crimped shall be prepared using this specifically designed machine.
- F. Mechanical joints are not allowed within walls.
- G. Manufacturer's Field Service: Arrange and pay for Manufacturer's engineer to provide the installation direction for a minimum onsite time of 1 day.
- H. Submit written approval of installation.

END OF SECTION 21 05 09

## SECTION 21 05 29 – HANGERS AND SUPPORTS FOR FIRE SUPPRESSION PIPING AND 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 the furnishing and installation of all pipe hanging and support systems.
- B. Division of Work: In accordance with the General Conditions, Contractor is responsible for dividing the Work among the Subcontractors and Suppliers and for delineating the work to be performed by specific trades. The following are suggestions as to how the Work may be divided. This is not a complete list of all the work:
  - 1. General Contractor: Coordinate work of this Section with other trades.
  - 2. Mechanical Subcontractor: All work of this Section except as listed under General Contractor.

#### 1.3 REFERENCES

- A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with the following:
  - 1. MSS - Manufacturers Standardization Society:
    - a. SP-58 - Pipe Hangers and Supports - Materials, Design and Manufacture.
    - b. SP-69 - Pipe Hangers and Supports - Selection and Application - 1996.
    - c. SP-90 - Guidelines on Terminology for Pipe Hangers and Supports.
  - 2. Hanger and supports for fire suppression systems shall also conform to the following standards published by the National Fire Protection Association in the National Fire Codes for fixed extinguishing equipment:
    - a. NFPA-13 - Installation of Sprinkler Systems.
  - 3. Hangers in general are covered in NFPA-13. If the system is other than a standard water sprinkler system, the applicable NFPA Standard shall also be consulted.

#### 1.4 DEFINITIONS

- A. Pipe Restraint: Pipe supporting element which is designed to limit or direct pipe movement due to internal static pressure, gravitational forces, frictional forces from hangers, rollers, and guides, and forces from expansion compensation devices:
  - 1. Pipe restraints are not designed to restrain pipe movement caused by thermal expansion, shock or surge.
- B. Pipe Guide: A pipe restraint designed to direct pipe movement along a single axis.
- C. Pipe Anchor: A pipe restraint designed to provide a static point about which pipe movement normally occurs, by limiting the longitudinal and axial movement at that point.
- D. Other Terms: As defined in MSS SP-90.

#### 1.5 DESIGN AND PERFORMANCE REQUIREMENTS

- A. Unless otherwise indicated on Drawings or in these Specifications, this Contractor shall be responsible to design and provide all pipe hangers, supports, restraints, braces, framing, etc., as required to comply with all applicable building codes, ASME B31 and MSS SP-69.
- B. Comply with the requirements of Division 21 Section "Water Based Fire Suppression Systems" for pipe hangers and supports for water based fire protection piping.

- C. The Work in this Section includes responsibility for all hangers, supports, restraints, braces, framing, etc. as required to comply with the seismic restraint requirements of the Michigan Rehabilitation Code for Existing Buildings of 2015.

## 1.6 SUBMITTALS

- A. Manufacturer's Literature: For structural steel attachment devices, hangers, and rollers. Include name of Manufacturer; model number and MSS Type, if applicable; and piping systems to be used with.
- B. Submit Shop Drawings for all engineered hanger, restraints, and support assemblies.
- C. Upon request by Engineer, submit calculations for all engineered hanger, restraints, and support assemblies.

## PART 2 - PRODUCTS

### 2.1 GENERAL REQUIREMENTS

- A. The materials of all pipe hanging and supporting elements shall be in accordance with the latest requirements of the ASME Code for Pressure Piping B31.1 and MSS Standard Practice MSS SP-58 and MSS SP-69 except as supplemented or modified by the requirements of these Specifications.
- B. The material in contact with the pipe shall be compatible with the piping material so that neither shall have a deteriorating action on the other.
- C. Special Finishes and Materials:
  - 1. All ferrous hangers and supports used in the following areas shall be hot dip galvanized unless noted otherwise:
    - a. Outside.
    - b. In wet or potentially wet areas.

### 2.2 MANUFACTURERS

- A. Elcon.
- B. Anvil.
- C. Bergen.
- D. Erico (Formerly Michigan Hanger).
- E. Hilti.
- F. Lindapter.
- G. PHD Manufacturing.

### 2.3 PIPE HANGERS AND SUPPORTS

- A. Horizontal Piping Hangers: Unless otherwise indicated and except as specified in piping system Specification sections, install the following types:
  - 1. Adjustable Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated stationary pipes, NPS 1/2 to NPS 30 (DN15 to DN750).
  - 2. Yoke Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 degrees F (49 to 232 degrees C) pipes, NPS 4 to NPS 16 (DN100 to DN400), requiring up to 4 inches (100 mm) of insulation.
  - 3. Carbon or Alloy Steel, Double Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24 (DN20 to DN600), requiring clamp flexibility and up to 4 inches (100 mm) of insulation.
  - 4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24 (DN15 to DN600), if little or no insulation is required.



5. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4 (DN15 to DN100), to allow off-center closure for hanger installation before pipe erection.
  6. Adjustable Swivel Split or Solid Ring Hangers (MSS Type 6): For suspension of non-insulated stationary pipes, NPS 3/4 to NPS 8 (DN20 to DN200).
  7. Adjustable Steel Band Hangers (MSS Type 7): For suspension of non-insulated stationary pipes, NPS 1/2 to NPS 8 (DN 15 to DN200).
  8. Adjustable Band Hangers (MSS Type 9): For suspension of non-insulated stationary pipes, NPS 1/2 to NPS 8 (DN15 to DN200).
  9. Adjustable Swivel Ring Band Hangers (MSS Type 10): For suspension of non-insulated stationary pipes, NPS 1/2 to NPS 2 (DN15 to DN50).
  10. Split Pipe Ring With or Without Turnbuckle Adjustment Hangers (MSS Type 11): For suspension of non-insulated stationary pipes, NPS 3/8 to NPS 8 (DN10 to DN200).
  11. Extension Hinged or 2 Bolt Split Pipe Clamps (MSS Type 12): For suspension of non-insulated stationary pipes, NPS 3/8 to NPS 3 (DN10 to DN80).
  12. U-Bolts (MSS Type 24): For support of heavy pipe, NPS 1/2 to NPS 30 (DN15 to DN750).
  13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
- B. Supports and Rollers:
1. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36 (DN100 to DN900), with steel pipe base stanchion support and cast iron floor flange.
  2. Pipe Stanchion Saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 36 (DN100 to DN900), with steel pipe base stanchion support and cast iron floor flange with U-bolt to retain pipe.
  3. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion type support for pipes, NPS 2-1/2 to NPS 36 (DN65 to DN900), if vertical adjustment is required, with steel pipe base stanchion support and cast iron floor flange.
  4. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30 (DN25 to DN750), from 2 rods if longitudinal movement caused by expansion and contraction might occur.
  5. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20 (DN65 to DN500), from single rod if horizontal movement caused by expansion and contraction might occur.
  6. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42 (DN50 to DN1050), if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
  7. Pipe Roll and Plate Units (MSS Type 45): For support of pipes, NPS 2 to NPS 24 (DN50 to DN600), if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
  8. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes, NPS 2 to NPS 30 (DN50 to DN750), if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.
- C. Vertical Piping Clamps: Unless otherwise indicated and except as specified in piping system specification sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20 (DN20 to DN500).
  2. Carbon or Alloy Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20 (DN20 to DN500), if longer ends are required for riser clamps.
- D. Hanger Rod Attachments: Unless otherwise indicated and except as specified in piping system specification sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches (150 mm) for heavy loads.
  2. Steel Clevises (MSS Type 14): For 120 to 450 degree F (49 to 232 degree C) piping installations.
  3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
  4. Malleable Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
  5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 degree F (49 to 232 degree C) piping installations.

- E. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Specification sections, install the following types:
1. Restraint Control Devices (MSS Type 47): Where indicated to control piping movement.
  2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches (32 mm).
  3. Spring Cushion Roll Hangers (MSS Type 49): For equipping Type 42 roll hanger with springs.
  4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
  5. Variable Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25% to absorb expansion and contraction of piping system from hanger.
  6. Variable Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25% to absorb expansion and contraction of piping system from base support.
  7. Variable Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25% to absorb expansion and contraction of piping system from trapeze support.
  8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load adjustment capability. These supports include the following types:
    - a. Horizontal (MSS Type 54): Mounted horizontally.
    - b. Vertical (MSS Type 55): Mounted vertically.
    - c. Trapeze (MSS Type 56): Two vertical type supports and 1 trapeze member.

#### 2.4 HANGER RODS

- A. Minimum rod diameters for rigid rod hangers shall be as shown in MSS SP-69 Table 4 (Minimum Rod Diameter for Single Rigid Rod Hangers) and as indicated in Part 3 of these Specifications.
- B. Hanger rods shall be subject to tensile loading only. At hanger locations where lateral or axial movement is anticipated, suitable linkage shall be provided to permit swing.
- C. Rod material must be compatible with hanger and comply with above. Do not field cut thread on galvanized rod.
- D. Do not use perforated strap.
- E. Multiple Supports:
  1. Horizontal banks of pipe may be supported on a common base member without regard to the pipe centerline elevation.
  2. In the supporting of multiple pipe runs, provisions shall be made to keep the lines in their relative lateral positions, using clamps or clips as required. Lines subject to thermal expansion shall be free to roll axially or slide.

#### 2.5 SADDLES AND SHIELDS

- A. All Piping:
  1. Saddle: MSS Type 39 (Grinnell #160-164), or Anvil Figure 162 or 165.
  2. Shield: MSS Type 40 (Grinnell #167), provide and install in accordance with Manufacturer's shield size selection tables.
  3. The contour of the saddle shall match the radius of the pipe insulation.

#### 2.6 ALIGNMENT GUIDES

- A. Provide at all expansion loops and joints:
  1. As indicated on the Drawings.
  2. As required to maintain alignment.
  3. In accordance with Expansion Joint Manufacturer's Association recommendations.

- B. Pipe Slides and Guides:
  - 1. Manufacturer:
    - a. Advanced Thermal Systems, Inc.
    - b. As approved by Owner.
  - 2. Model:
    - a. Figure 101-W for guide weld down applications.
    - b. Figure 101-B for guide bolt down applications.
    - c. Figure 201-W for slide weld down applications.
    - d. Figure 201-B for slide bolt down applications.
  - 3. Size: Appropriate for pipe size, insulation thickness and length of travel.
  - 4. Minimum Length of Travel:
    - a. For the first 1/4 of the distance from the anchor to the expansion joint -25% of design travel length of joint.
    - b. For the second 1/4 of the distance from the anchor to the expansion joint -50% of design travel length of joint.
    - c. For the third 1/4 of the distance from the anchor to the expansion joint -75% of design travel length of joint.
    - d. For the last 1/4 of the distance from the anchor to the expansion joint - design travel length of joint +25%.
- C. Spider Type Guides:
  - 1. Manufacturers:
    - a. ITT Grinnell.
    - b. Michigan Hanger.
    - c. Keflex.
  - 2. Minimum 12 inches long.
  - 3. Grinnell P-Series, Figure 25L; or equal.

## 2.7 FABRICATED STEEL SUPPORTS AND RESTRAINTS

- A. Provide as required:
  - 1. Steel shapes and plates.
  - 2. Bolts.
  - 3. Welds.
- B. Materials and fabrication in accordance with:
  - 1. AISC Specification for the Design, Fabrication and Erection of Structural Steel for Buildings.
  - 2. AISC Code of Standard Practice for Steel Buildings and Bridges (except Section 4.2.1.).
- C. Design: Responsibility of Subcontractor.
- D. Paint all finished fabrications:
  - 1. As specified in Division 09 Section "Interior Painting."
  - 2. Color as directed by Owner.

## 2.8 BUILDING ATTACHMENTS

- A. As indicated on the Drawings or in the Specifications.
- B. Concrete Attachments:
  - 1. Provide galvanized finish for all attachments used in wet or potentially wet areas.
  - 2. Provide stainless steel bolts and nuts in wet and potentially wet areas.
  - 3. Poured Concrete:
    - a. Use cast-in-place inserts or bolted surface mounted attachments, at Contractor's option.
    - b. Expansion style anchors are not permitted on piping systems subject to vibration.
  - 4. Precast Concrete Tees:
    - a. Use fittings specifically designed for attachment to stems of precast tees.
    - b. Drilling is not permitted except where specifically approved by Engineer and coordinated with precast Manufacturer to miss embedded, prestressed steel strands.

5. Precast Concrete Plank:
  - a. Use toggle bolt attachment as indicated on Drawings.
  - b. Alternatively, provide adhesive anchor, Hilti HY-20; or as approved.
  - c. Drilling is not permitted except where specifically approved by Engineer and coordinated with precast Manufacturer to miss embedded, prestressed steel strands.
- C. Horizontal Piping:
  1. Steel W, I, or S shapes: MSS Type 23 clamp with retaining clip, (Grinnell Fig. 87) up to 2-inch; MSS Type 28 (Grinnell Fig. 292) or MSS Type 21 (Grinnell Fig. 133, 134) above 2-inch.
  2. Steel Channel: MSS Type 20 universal channel clamp.
  3. Bar Joists: Steel washer plate (Grinnell Fig. 60).
  4. Concrete: See "B" above.
- D. Vertical Piping:
  1. Steel Shapes: Welded brackets as approved by Engineer.
  2. Concrete: See "B" above.
- E. In the absence of a Specification for a particular type of attachment, furnish attachments comparable in type and quality to that specified above for a similar situation.

## 2.9 METAL FRAMING PIPE SUPPORT SYSTEMS

- A. Acceptable Manufacturers:
  1. Eaton B-Line.
  2. Elcen.
  3. Super Strut, Inc.
  4. Unistrut Building Systems.
- B. Provide products from one Manufacturer.
- C. Channel (Standard Applications):
  1. Mild strip steel.
  2. 12 gage minimum material.
  3. Factory painted equal to Unistrut Perma-Green.
  4. Equal to Unistrut Part No. P1000.
- D. Clamps and Supports:
  1. Beam clamp equal to Unistrut Part No. P2785.
  2. Pipe strap equal to Unistrut Part No. P2558.
  3. Pipe roller equal to Unistrut Part No. P2474.
  4. All items fabricated in material equal to channel specifications.
- E. Clamp Nuts:
  1. Electro-galvanized stainless steel for use with stainless steel and fiberglass parts.
  2. Mild bar steel for standard applications.
  3. Class 2 American Standard threads.
  4. Equal to Unistrut Part No. P1012.

## PART 3 - EXECUTION

### 3.1 HANGER AND SUPPORT APPLICATIONS

- A. General Requirements:
  1. The selection of pipe hangers and supports shall be based on the overall design concept of the piping system and any special requirements which may be called for in these Specifications or as indicated on the Drawings. The support systems shall provide for, and control, the free or intended movement of the piping including its movement in relation to that of the connected equipment. They shall prevent excess stress resulting from the transfer of weight being introduced into the pipe or connected equipment.

2. The selection of hangers and supports shall be made to provide the piping system with the degree of control that its operating characteristics require.
  3. The selection of hangers or supports will take into consideration the combined weight of the supported systems, including system contents and test water.
  4. Select and install hangers and supports to allow controlled thermal and seismic movement of piping system, to permit freedom of movement between pipe anchors, and facilitate action of expansion joints, expansion loops, expansion bends and similar units.
  5. The spans in MSS SP-69 Table 3 do not apply where concentrated weights, such as valves or heavy fittings, or where changes in direction of the piping occur between hangers.
  6. Select all hangers and supports rated for the maximum potential loading with pipe full.
  7. Select hangers for cold (less than 50 degrees F) piping service for installation over the insulation.
  8. Where significant, vertical movement of pipe occurs at the hanger location a resilient support must be used:
    - a. Selection of resilient supports shall be based on permissible load variations and effects on adjacent equipment. Support selection for typical load variations are shown on MSS SP-69 Table 2 (Spring Support Selection). Load and movement calculations shall be made for the proper selection of spring hangers.
    - b. Vertical movement and load transfer from riser expansion to horizontal runs shall be given consideration when applying spring hangers.
    - c. Spring cushion hangers may be used where vertical movement does not exceed 1/4-inch and where formal load and movement calculations are not required.
    - d. Variable spring hangers shall be used for all other resilient support requirements except as noted in the following paragraph.
    - e. Constant support hangers shall be used on piping systems where the deviation in supporting force must be limited to 6% and which cannot be accommodated by a variable spring hanger.
- B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Specification sections.

### 3.2 HANGER AND SUPPORT INSTALLATION

- A. Pipe Hanger and Support Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. General:
1. Adjust all components as required for proper operation and required pipe slope.
  2. Double nut all support rods at hangers.
  3. Location and Routing:
    - a. Install Piping as Indicated:
      - 1) On the Drawings.
      - 2) On the reviewed Shop Drawings.
    - b. Secure Engineer's approval for all pipe routing changes.
  4. Coordinate with other trades for placement of concrete attachments prior to concrete pouring.
  5. Install all items in accordance with Manufacturer's instructions.
- C. Support at Valves: Provide additional supports at all valves in piping 4-inch and larger.
- D. Vertical Risers:
1. Support independently from adjacent hangers on horizontal piping.
  2. Cast Iron Waste, Vent or Drainage Piping:
    - a. Support at the base and at each floor level.
    - b. Support spacing not to exceed 15-foot centers.
  3. Copper Piping:
    - a. Support at the base and at 6-foot maximum centers for sizes 1-1/4-inch and smaller.
    - b. Pipes Larger Than 1-1/4-Inch:
      - 1) Supported at each floor level.
      - 2) Not to exceed 10-foot centers.
  4. Vertical Threaded, Welded or Grooved Steel Piping:
    - a. Support at the base of the riser and at every other floor.
    - b. Maximum allowable unsupported piping length is 12 feet.

- E. Horizontal Runs:
  - 1. General:
    - a. Provide adequate supports for the loads with a factor of safety of at least 5 (400 pounds minimum).
    - b. Provide protective shield at all hangers and rollers supporting plastic pipe and coated pipe.
    - c. Support spacing not to exceed MSS SP-69 Table 3, or the requirements for seismic restraint, whichever is more stringent.
    - d. Hanger rod diameter shall not be less than the requirements of MSS SP-69 Table 4, or the requirements for seismic restraint, whichever is more stringent.
  - 2. Rollers: All piping systems designed to accommodate thermal expansion movement shall be mounted on rollers.
  - 3. Bar Joists: Attachments to bar joists shall be made to top member and at panel points.
- F. Ductile Iron Piping: The size of hanger components shall be suitable for the O.D. of the pipe to be supported.

### 3.3 PIPE RESTRAINTS

- A. Provide adequate pipe restraints for all expansion or contraction of piping due to temperature change:
  - 1. Including, but not limited to, that indicated on the Drawings.
  - 2. As instructed by Owner or Engineer.
  - 3. At locations to prevent stresses from exceeding those permitted by ANSI B31 and to prevent transfer of loading and stresses to connected equipment.
  - 4. Spacing: Unless otherwise indicated, install at ends of main pipe runs, at intermediate joints in pipe runs between expansion loops and bends.
- B. Concrete work installed in connection with anchors or supports: Make with approved Portland Cement:
  - 1. At least 5-1/2 bags per cubic yard.
  - 2. Properly mixed with approved aggregate.
  - 3. Attain a compression strength of not less than 3,000 psi at 28 days.

### 3.4 PAINTING

- A. Touchup: Cleaning and touchup of painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 Section "Interior Painting."
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas. Apply galvanizing repair paint to comply with ASTM A780.

END OF SECTION 21 05 29

## SECTION 21 05 31 – PENETRATIONS FOR FIRE SUPPRESSION

### 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 furnishing and installation of the major items listed below:
  - 1. Pipe sleeves.
  - 2. Flashing and sealing of all mechanical openings through weather or waterproofed walls, roofs and floors.
  - 3. Sealing and finishing of all mechanical openings.
  - 4. Provide UL rated firestopping and sealing at all new and existing pipe penetrations of fire rated walls.
- B. Division of Work: In accordance with the General Conditions, Contractor is responsible for dividing the Work among the Subcontractors and Suppliers and for delineating the work to be performed by specific trades. The following are suggestions as to how the Work may be divided. This is not a complete list of all the work:
  - 1. General Contractor:
    - a. Locate and place all sleeved and framed openings as part of constructing the wall and floor surfaces in which the openings occur.
    - b. Provide all lintels and required stiffening members for wall and floor openings.
    - c. Cut roofing and install flashing for all required openings in proprietary roof membrane systems.
    - d. Cut all roof deck openings and provide required framing supports.
  - 2. Fire Suppression Subcontractor:
    - a. Advise General Contractor of quantity, location and size of all required openings.
    - b. Provide all curbs, sleeves, seals, escutcheons and related materials required for finishing, sealing and waterproofing mechanical openings. Furnish all flashing and counterflashing.
    - c. Arrange and pay for all openings required after wall, roof and floor construction is complete.

#### 1.3 REFERENCES

- A. Except as herein specified or as indicated on the Drawings, the Work of this Section shall comply with ASTM D2202 - Test Method for Slump of Sealants.

#### 1.4 SUBMITTALS

- A. Manufacturer's Literature: For all premanufactured curbs and sealing assemblies.
  - 1. Manufacturer's name.
  - 2. Model number.
  - 3. Details of construction and installation.
  - 4. Certified load-bearing data for all curbs.

#### 1.5 QUALITY ASSURANCE

- A. Fabrication and Installation Personnel Qualifications:
  - 1. Trained and experienced in the fabrication and installation of the materials and equipment.
  - 2. Knowledgeable of the design and the reviewed submittals.
- B. Openings in Fire-Rated Surfaces: As specified in Division 07 Section "Firestopping."

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Pipe Seals and Boots:
  - 1. The Pate Company.
  - 2. Portals Plus, Inc.
  - 3. Roof Products and Systems Corporation.
  - 4. Thunderline Corporation.
  - 5. Thycurb Corporation.
- B. Modular Mechanical Seals:
  - 1. Thunderline/Link-Seal.
  - 2. As approved.
- C. Backer Rod: Industrial Thermo Polymers, "Standard Backer Rod".
- D. Acoustical Sealant: Pecora, "BA-98".
- E. Non-Expanding Sealant: General Electric SilPruf SCS2000:
  - 1. VOC content must be 250 g/liter or less.

### 2.2 MATERIALS

- A. Backer Rod:
  - 1. Extruded round, closed cell, polyethylene foam.
  - 2. Resilient, non-exuding.
  - 3. Density: 2.0 pounds per cubic foot.
  - 4. Tensile Strength: 50 psi.
  - 5. Nonabsorbent to water and gasoline.
  - 6. Suitable for use as a backing for acoustical sealant.
  - 7. Compatible with sealant and approved by sealant Manufacturer.
- B. Acoustical Sealant:
  - 1. Nonfire-Rated Penetrations:
    - a. Non-drying, non-hardening and non-bleeding.
    - b. Laboratory tested sealant which effectively reduces airborne sound transmission through wall systems.
    - c. Viscosity: 350,000 to 400,000 (Brookfield No. 65, 10 RPM).
    - d. Aging: Firm but rubbery, good tack after 50 days conditioned at 160 degrees F.
    - e. Slump: 0.1 to 0.2 inches in accordance with ASTM D2202.
    - f. Color: Gray.
  - 2. Fire-Rated Penetrations: Permanently flexible, approved firestop putty. Refer to Division 07 Section "Firestopping."
- C. Packing Material for Penetrations:
  - 1. Glass Fiber or Mineral Fiber:
    - a. Noncombustible.
    - b. Resistant to water, mildew, and vermin.
  - 2. Expanding Resilient Foams:
    - a. Acceptable alternative if manufactured for this purpose.
    - b. Minimum material density: 60 pounds per cubic foot.



## 2.3 SLEEVES

- A. Materials:
  - 1. 18-Gage Galvanized Steel: For pipe penetrations in non-bearing walls.
  - 2. Schedule 40 Steel Pipe:
    - a. For all bearing walls.
    - b. For all floors.
  - 3. Cast Iron Pipe: For all exterior below grade installations.
- B. Size All Sleeves:
  - 1. To allow for movement due to expansion.
  - 2. To provide for continuous insulation, except as required by Division 07 Section "Firestopping."
  - 3. As indicated on the Drawings.

## 2.4 MANUFACTURED UNITS

- A. Exterior Pipe Opening Seals:
  - 1. Compatible with installation conditions.
  - 2. Equal to One of the Following:
    - a. Pate "Pipe Seal".
    - b. Portals Plus Model C-126.
  - 3. Link-Seal.
- B. Modular Mechanical Seals:
  - 1. Provide modular, mechanical type, consisting of inter-locking synthetic rubber links shaped to continuously fill the annular space between the pipe and the wall opening.
  - 2. The elastomeric element shall be sized and selected in accordance with Manufacturer's recommendations and have the following properties as designated by ASTM:
    - a. For Standard Service Applications:
      - 1) -40 to +250 degrees F (-40 to +121 degrees C).
      - 2) EPDM = ASTM D2000 M3 BA510.
    - b. For High Temperature or Fire Seal Applications:
      - 1) -67 to +400 degrees F (-55 to +204 degrees C).
      - 2) Silicone = ASTM D2000 M1GE505.

## PART 3 - EXECUTION

### 3.1 INTERIOR WALL AND FLOOR OPENINGS

- A. Use riser sleeve with integral flashing flange and clamp for all waterproof membrane floors.
- B. Seal airtight all openings around pipes in the structure at:
  - 1. Mechanical equipment rooms.
  - 2. Noise-critical spaces including all penetrations in walls separating the Plant areas from the Office areas.
  - 3. Slab and noise sensitive wall penetrations.
  - 4. Penetrations of all drywall ceilings and concrete slabs suspended on isolators.
  - 5. All enclosed shaft penetrations.
- C. Pipe Penetrations:
  - 1. Where a pipe passes through a wall, ceiling, or floor slab, cast or grout a steel sleeve into the structure.
  - 2. Internal diameter of the sleeve: 2 inches (50 mm) larger than the external diameter of the pipe passing through it.
  - 3. After all of the piping is installed in a specific area, check the clearance and correct it, if necessary, to within 1/2-inch (12 mm).
  - 4. Pack the void full depth with packing material and seal at both ends, 1-inch (25 mm) deep.
  - 5. In noise-critical walls and floors, pack with sealant backed by foam rod.

6. Where pipes pass through a masonry wall in sufficient numbers and density that individual pack-and-caulk details are not possible, a special isolation detail shall be developed:
  - a. Cast pipe sleeves in a block of concrete with the sleeves located a minimum of 2 inches (50 mm) apart.
  - b. Block thickness: At least as thick as the surrounding wall construction.
  - c. Each sleeve diameter: 2 inches (50 mm) larger than the external diameter of the pipe passing through it.
  - d. Build the sleeved block into the wall.
  - e. After the pipes are installed, pack and caulk voids as indicated above.
7. Fire Protection and Compressed Air Pipes:
  - a. May be sleeved and sealed as indicated above, or (except where crossing an acoustic joint) may be grouted and caulked into the structure as follows:
    - 1) Before grout has set, rake a 1/2-inch deep (12 mm by 12 mm) groove around the pipe on each side of the wall or slab.
    - 2) After the grout has set, fill groove full depth with sealant.
  - b. Penetration of sound isolating ceilings (concrete or multi-layer drywall) by fire protection pipes and heads shall be sleeved and sealed as indicated herein. There shall be no rigid connection between ceiling and pipes or heads.

### 3.2 OUTSIDE WALL OPENINGS

- A. Pipes:
  1. Pass through sleeves fabricated of Schedule 40 pipe cut 3/8-inch back from face of wall on each side.
  2. Sealed 100% watertight.
  3. Pipes below grade use cast iron sleeves.

### 3.3 FLOOR SLEEVES IN POTENTIALLY WET AREAS

- A. All floors except slabs on grade.
- B. Extend sleeves 3 inches above finished floor.
- C. Provide poured concrete curb for duct openings as indicated in the Drawings.

### 3.4 ESCUTCHEONS AND CLOSURE COLLARS

- A. Includes ceilings, partitions, floor and walls.
- B. Provide Escutcheons for All Piping:
  1. As indicated on the Drawings.
  2. Sized to fit over coverings.
  3. In All Potentially Wet Areas: Stainless steel.
  4. In All Dry Finished Areas: Chrome plated.
  5. Do not use escutcheons in acoustic isolation walls unless otherwise indicated.

END OF SECTION 21 05 31

## SECTION 21 10 00 – WATER BASED FIRE SUPPRESSION 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. This Section includes the design, furnishing, and installation of a fire protection system:
1. Water supply, above and below ground single water source.
  2. Wet pipe system with sprinklers.
  3. Backflow preventer.
  4. Controls.
  5. Inspector's test station(s).
  6. Post indicator valve.
- B. Division of Work: In accordance with the General Conditions, Contractor is responsible for dividing Work among the Subcontractors and Suppliers and for delineating the work to be performed by specific trades. The following are suggestions as to how Work may be divided. This is not a complete list of all Work:
1. Fire Protection Subcontractor:
    - a. Prepare system design and layout.
    - b. Furnish and install all system piping and components including, but not necessarily limited to, flow switches, valve supervisory switches, and air pressure switches.
    - c. Secure approvals from agencies having jurisdiction.
    - d. Ensure that final installation, as constructed, complies with fire protection requirements and does not subject any part of this system to unnecessary risk of freezing or other damage.
  2. Electrical Subcontractor: Provide all necessary wiring interface and wire to building fire alarm system including, but not necessarily limited to, wiring of alarm bells, flow switches, valve supervisory switches, and air pressure switches.
  3. General Contractor:
    - a. Provide access to all valves, sprinkler heads and devices.
    - b. Provide louvers, heat trace or other means to protect all wet parts of the system from freezing.

#### 1.3 REFERENCES

- A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with the following:
1. ANSI/ASME Standards:
    - a. A17.1 - Safety Code for Elevators, Dumbwaiters, Escalators and Moving Walks.
    - b. B16.3 - Malleable-Iron Threaded Fittings, Classes 150 and 300.
    - c. B16.9 - Factory-Made Wrought Steel Buttwelding Fittings.
    - d. B16.25 - Buttwelding Ends.
    - e. B36.10M - Welded and Seamless Wrought Steel Pipe.
  2. ANSI/AWWA Standard:
    - a. C104/A21.4 - Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
    - b. C110/A21.10 - Ductile-Iron and Gray-Iron Fittings, 3-inch through 48-inch, for Water and Other Liquids.
    - c. C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings.
    - d. C150/A21.50 - Thickness Design of Ductile-Iron Pipe.
    - e. C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast, for Water or Other Liquids.
  3. ASTM Specification:
    - a. A53 - Specifications for Welded and Seamless Steel Pipe.
    - b. A126 - Gray-Iron Castings for Valves, Flanges, and Pipe Fittings.
    - c. A135 - Specifications for Electric Resistance Welded Pipe.
    - d. A197 - Cupola Malleable Iron.
    - e. A234 - Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.

- f. B75 - Specification for Seamless Copper Tube.
- g. B88 - Specifications for Seamless Copper Tube.
- h. B251 - Specifications for General Requirements for Wrought Seamless Copper and Copper- Alloy Tube.
- 4. AWWA Standards:
  - a. C105 - Polyethylene Encasement for Ductile Iron Pipe Systems.
  - b. C500 - Metal-Seated Gate Valves for Water Supply Service.
- 5. AWS A5.8 - Specification for Filler Metals for Brazing.
- 6. NFPA Standards:
  - a. 13 - Installation of Sprinkler Systems.
  - b. 24 - Installation of Private Fire Service Mains and their Appurtenances.
  - c. 25 - Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.
  - d. 1963 - Standard for Fire Hose Connections.
- 7. UL:
  - a. 193 - Alarm Valves for Fire Protection Service.
  - b. 260 - Standard for Safety for Dry Pipe and Deluge Valves for Fire Protection Service.
  - c. 262 - Gate Valves for Fire Protection Service.
  - d. 312 - Check Valves for Fire Protection Service.
  - e. 668 - Hose Valves for Fire Protection Service.
  - f. 753 - Alarm Accessories for Automatic Water-Supply Control Valves for Fire Protection Service.
  - g. 789 - Indicator Posts for Fire Protection Services.

#### 1.4 DESIGN AND PERFORMANCE REQUIREMENTS

- A. System layout and design responsibility are included as work of this Section.
  - 1. Details of construction, quantities, components and accessories indicated on the Drawings and in the specifications are minimum requirements.
  - 2. Minimum design criteria are as specified herein and as indicated on the Drawings.
  - 3. Confirm final design requirements with the authority or authorities having jurisdiction and the Owner's insuring agency.
  - 4. Increases in system component requirements beyond these minimums that are determined by the system designer to be necessary to provide the functional intent and for a complete system shall not be a basis for an increase in cost to Owner.
  - 5. Final Design:
    - a. The equipment and piping sizes and selections, where indicated on the Drawings, are minimum requirements and have been determined through the application of good engineering practice and standard calculation methods based on the best information available at the time that these documents were produced. A complete layout and hydraulic analysis has not been done.
    - b. It is the responsibility of Contractor to verify all assumptions and design elements used as the basis of the preliminary design and to perform final calculations, sizing and selections as necessary to comply with the performance criteria specified herein and NFPA 13.
    - c. The primary water source, and only the primary water source (the supply pipe size and, if applicable, as indicated in these documents is to be used as the basis for Bid. If, after completion of complete hydraulic analysis, a material change in any or all of the components of the primary water source is required, an adjustment in the Contract will be considered only after all layout and sizing options have been considered.
      - 1) A fire pump is not expected to be necessary to meet the requirements of this project. All layout and sizing options must be evaluated by hydraulic analysis before a pump will be considered.
    - d. A 20% margin of safety shall be included.
- B. Intent of Contract Documents:
  - 1. Indicate general areas to be sprinklered.
  - 2. Indicate primary water service location and size.
  - 3. Indicate flow and pressure test data used as basis for Drawings.
  - 4. Indicate riser locations.
  - 5. Locate fire hose and fire department valve cabinet.
  - 6. Do not indicate complete system requirements.
  - 7. Do not necessarily indicate all incidental areas, such as attics, platforms and adjacent concealed spaces as may be required to be sprinklered.

- C. Sprinkler System Layout:
  - 1. Sprinkler piping shall consist of straight tree, side feed tree, looped, or gridded configurations.
  - 2. Straight tree, side feed tree and looped configurations may be designed according to pipe schedule system or hydraulically calculation.
  - 3. Gridded configuration shall only be designed according to hydraulic calculation.
  
- D. Occupancy Hazard Fire Control Approach:
  - 1. Water demand requirements shall be determined from the occupancy hazard fire control approach in accordance with NFPA 13:
    - a. Special design approaches are allowed only in accordance with the provisions of NFPA 13.
  - 2. Occupancies or portions of occupancies shall be classified according to the quantity and combustibility of contents, the expected rates of heat release, the total potential for energy release, the heights of stockpiles, and the presence of flammable and combustible liquids.
  
- E. Protection Area Limitations: Maximum coverage per occupancy hazard shall be as indicated below:
  - 1. Light Hazard: 52,000 square feet.
  - 2. Ordinary Hazard: 52,000 square feet.
  - 3. Extra Hazard:
    - a. Pipe Schedule: 25,000 square feet.
    - b. Hydraulically Calculated: 40,000 square feet.
    - c. Storage: High piled and other standards: 40,000 square feet.

## 1.5 SUBMITTALS

- A. Preliminary Design Submittal:
  - 1. Provide in its entirety the following information:
    - a. Name of Owner and occupant.
    - b. Location, including street address.
    - c. Point of compass.
    - d. Building construction, obstructed versus unobstructed.
    - e. Sprinkler spacing, location, style, temperature, finish and coating, on reflected ceiling plans.
    - f. Water Supply:
      - 1) One or more adequate hydrants.
      - 2) Existing Water Mains: Size, type and location.
      - 3) New Water Connections and Mains: Size, type and location.
      - 4) Hydrant flow test conducted within the last 6 months: Location, elevation, seasonal low, date and time of test.
    - g. Design Approaches, Plans, and Calculations:
      - 1) Most remote demanding area coverage.
      - 2) Density.
      - 3) C-factor for pipe.
      - 4) K-factor for sprinkler head orifice.
      - 5) Minimum flow, discharge pressure, water supply curve.
      - 6) Hydraulic calculations.
      - 7) Scaled plans of piping system with pipe sizes and node numbering indicated.
    - h. Sprinklers:
      - 1) Style.
      - 2) Temperature.
      - 3) Finish and coating.
    - i. Hangers:
      - 1) Maximum distance.
      - 2) Proper type for structure and pipe size.
    - j. Pipes and Fittings:
      - 1) Correct joints for pipes.
      - 2) Fitting pressure rating.
      - 3) Special corrosion resistant piping.
      - 4) Sleeves through floors and walls.

- k. Valves:
            - 1) Control Valves: Type, locations, and supervision.
            - 2) Drains: Size, type, and adequacy.
            - 3) Inspectors test.
          - l. Fire Department Connection:
            - 1) Location.
            - 2) Connection: Confirm thread index with responding fire department.
2. Obtain Approval From:
  - a. Agency and authorities having jurisdiction.
  - b. Including, but not limited to:
    - 1) Owner's insurer.
    - 2) Local authorities.
3. Do not submit to approval agency until Engineer has reviewed the Submittal. Engineer's comments shall be incorporated into Drawings submitted to approving agency.
- B. Final Design Submittal:
  - 1. Submit to Engineer for review only after approving agency or agencies have approved Submittal.
  - 2. Submit 8 sets, 2 of which shall bear approving agency stamp.
  - 3. Submit attached letter of explanation explaining in detail all of Engineer's comments noted on preliminary Submittal that have not been incorporated in final Submittal.
  - 4. Should Engineer not accept letter of explanation stated above, incorporate comments into resubmitted final Submittal at no additional cost to Owner.
- C. Engineer's Design Submittal Review: Review of preliminary and final submittals does not relieve Contractor of responsibility for design and compliance with regulatory requirements and those of the Contract Documents.
- D. Pressure Test Reports:
  - 1. Submit within 1 week after each system pressure test.
  - 2. List time, date and persons present for the following for each system:
    - a. Initial tests.
    - b. Final tests.
  - 3. Include report indicating:
    - a. Test type and duration.
    - b. Initial pressure.
    - c. Final pressure.
  - 4. Indicate that necessary repairs and final tests were satisfactorily completed.
- 1.6 QUALITY ASSURANCE
- A. Qualifications:
    - 1. Installation Subcontractor: Certified by the state in which the work is performed.
    - 2. Fabrication and Installation Personnel:
      - a. Trained and experienced in the fabrication and installation of the materials and equipment.
      - b. Knowledgeable of the design and the reviewed submittals.
      - c. All grooved couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.
  - B. System installation and components shall comply with NFPA 13.
  - C. System testing shall comply with NFPA 25.
  - D. Comply with requirements of the following agencies:
    - 1. Owner's insurer.
    - 2. State Fire Marshal.
    - 3. Local authorities having jurisdiction.
  - E. Agency Approvals: All components critical to operation or otherwise required by NFPA or the Owner's insurer shall be documented for compliance with the following:
    - 1. Underwriter Laboratories listed.
    - 2. Factory Mutual approved.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials in original, unbroken, brand marked containers or wrapping as applicable.
- B. Handle and store materials in a manner which will prevent deterioration or damage; contamination with foreign matter - each end of pipe shall be capped, plugged, or taped; or damage by weather or elements; and in accordance with Manufacturer's directions.
- C. Reject damaged, deteriorated, or contaminated material and immediately remove from the Site. Replace rejected materials with new materials at no additional cost to Owner.

1.8 SEQUENCING AND SCHEDULING

- A. Contractor's attention is called to ductwork, heating and cooling piping, water and drain piping, and electrical systems. Coordinate these systems to avoid conflict in elevations of the systems where same may cross each other. Determine which trade shall start work first on project.

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. Sprinkler Cabinets:
    - a. Finished, wall-mounting, steel cabinet with hinged cover, with a minimum of 6 spare sprinklers plus sprinkler wrench.
    - b. Include number of sprinklers required by NFPA 13 and sprinkler wrench.

PART 2 - PRODUCTS

2.1 PIPE, FITTINGS, AND HANGERS

- A. Underground Pipe and Fittings:
  - 1. Ductile Iron Pipe, ANSI A21.50 and A21.51:
    - a. Wall Thickness: Class 52, except as indicated otherwise.
    - b. Cement Mortar Lining: ANSI A21.4.
  - 2. Joints:
    - a. ANSI A21.11.
    - b. U.S. Pipe TR FLEX restrained or equal.
  - 3. Main Line Fittings:
    - a. Short Bodied, ANSI A21.10, Restrained Joint with Cement Mortar Lining:
      - 1) Restrained Joints: ANSI A21.11.
      - 2) Working Pressure: 250 psi.
  - 4. Encase all underground metal pipe in ASTM A674 or AWWA C105 polyethylene film, minimum 0.008-inch thickness.
- B. Above Ground Pipe and Fittings:
  - 1. Pipe:
    - a. Steel Pipe in Accordance with ASTM A135, or ASTM A53:
      - 1) Welded: Schedule 40.
      - 2) Threaded or Cut Groove:
        - a) Schedule 40 for sizes less than 8 inches.
        - b) Schedule 30 for sizes 8 inches or larger.
    - b. Hot-dip galvanized steel pipe is required on all dry systems and pre-action systems.
  - 2. Fittings:
    - a. All steel, cast iron, and ductile iron fittings used on galvanized piping shall be galvanized.
    - b. Standard weight steel, butt weld type conforming to ANSI B16.9 and ASTM A234.
    - c. Screwed Fittings:
      - 1) Permitted in pipe sizes 2 inches and smaller.
      - 2) Conforming to ANSI B16.3 or B16.4, as applicable, and ASTM A197.

- d. Extra Heavy Pattern (Required When Pressures Exceed 175 psi):
  - 1) Standard weight cast iron fittings 2 inches and smaller are acceptable if pressures do not exceed 300 psi.
  - 2) Standard weight malleable iron fittings 6 inches and smaller are acceptable if pressures do not exceed 300 psi.
  - 3) Grooved pipe couplings and fittings as specified in Division 21 Section "Steel Pipe and Fittings for Fire Suppression."
- C. Quick Fit Sprinkler Tee: Only allowed in warehouses and plant areas.
  - 1. Manufacturer: Victaulic; or approved equal.
  - 2. Description:
    - a. Cast iron housing in accordance with ASTM A126.
    - b. Finished with a rust inhibitor paint.
    - c. Minimum of 1 carbon steel bolt on each side of sprinkler head connection.
    - d. Gasket in accordance with ASTM D2000.
- D. Flexible Connectors:
  - 1. Manufacturer: Victaulic VicFlex Series AH1, AH2 or AH2-CC only.
  - 2. UL listed.
  - 3. FM approved.
  - 4. 300-Series type 304 stainless steel braided flexible tube.
  - 5. 175 psi maximum working pressure for UL listed and 200 psi for FM approved, 225-degrees F maximum working temperature,
  - 6. Gasket: EPDM.
  - 7. Brackets: VicFlex Series AB1 or AB2 mounting brackets.
  - 8. All hoses shall be factory pressure tested to 400 psi.
- E. Hangers and Supports: Comply with requirements of Division 21 Section "Hangers and Supports for Fire Suppression Piping and Equipment" for selection of pipe hangers and supports.
- F. Bending - Schedule 40 and Type K and L Copper:
  - 1. 2 inches and smaller pipe requires radius of 6 pipe diameters.
  - 2. 2-1/2 inches and larger pipe requires radius of 5 pipe diameters.
- G. Return Bends:
  - 1. Return bends are required on all non-potable water systems.
  - 2. Return bends are not required on deluge and dry pendant sprinkler systems.
  - 3. Grooved pipe couplings and fittings as specified in Division 21 Sections "Steel Pipe and Fittings for Fire Suppression" and "Copper Pipe and Fittings for Fire Suppression."

## 2.2 SPRINKLER SPECIALTY FITTINGS

- A. Fittings:
  - 1. UL listed or FM approved, with 175 psig minimum working pressure rating, and made of materials compatible with piping;
  - 2. Fittings shall have 300 psig minimum working pressure rating if fittings are components of high pressure piping system.
- B. Sprinkler Drain and Alarm Test Fitting: Cast or ductile iron body with threaded or locking lug inlet and outlet, test valve, and orifice and sight glass Manufacturers:
  - 1. Fire-End and Croker Corporation.
  - 2. Globe Fire Sprinkler Corp.
  - 3. Tyco Fire Products.
  - 4. Victaulic Series 747.
  - 5. Viking Corporation.



- C. Sprinkler Branch Line Test Fittings: Brass body with threaded inlet, capped drain outlet, and threaded outlet for sprinkler Manufacturers:
  - 1. Elkhart Brass Manufacturing Company, Inc.
  - 2. Fire-End and Croker Corporation.
  - 3. Potter-Roemer; Fire-Protection Division.
- D. Sprinkler Inspector's Test Fitting: Cast-bronze or ductile-iron housing with threaded or grooved inlet and drain outlet and sight glass Manufacturers:
  - 1. AGF Manufacturing Company.
  - 2. Globe Fire Sprinkler Corp.
  - 3. Triple R Specialty of Ajax, Inc.
  - 4. Tyco Fire Products.
  - 5. Victaulic Style 720 "TestMaster II."
- E. Automatic Air Vents: Wet Pipe System Vent: Brass body automatic air venting valve, integrated ball valve, stainless steel strainer, purge valve with 3/4-inch NPT outlet, Manufactured by AGF PurgenVent, or equal.

### 2.3 SPRINKLER HEADS

- A. UL listed with 175 psig minimum pressure rating.
- B. Manufacturers:
  - 1. Viking.
  - 2. Reliable Corporation.
  - 3. Tyco.
  - 4. Victaulic.
  - 5. Globe.
- C. Bulb: Temperature rating of temperature activated color coded glass bulbs or fused link plates in accordance NFPA 13 or as dictated by authority having jurisdiction.
- D. Mounting and Finish:
  - 1. In areas with suspended ceilings, provide concealed type sprinklers with cover plate factory-finished in off-white baked enamel, or flat black enamel in area with black ceilings.
  - 2. Provide concealed type sprinklers with cover plate factory-finished in off-white baked enamel.
  - 3. In areas without suspended ceilings, heads shall be bronze finish, up-right type.
  - 4. Bronze finish pendent heads may be used in Storage Rooms and Janitor's Closets.
  - 5. Provide and install sprinkler guards when sprinkler subject to mechanical injury or when ceiling is at 7'-0" or less to finished floor.
  - 6. Sidewall chrome plated sprinklers for extended coverage or as required: Restrain wall-mounted sidewall sprinkler to prevent movement.
  - 7. Dry sprinkler heads shall be used on any part of a wet system subject to freezing.

### 2.4 VALVES

- A. UL listed or FM approved with a 175 psig minimum pressure rating. When water pressure exceeds 175 psi, valves shall be used in accordance with their pressure ratings.
- B. Interior Valves:
  - 1. Manufacturer:
    - a. Clow.
    - b. Crane.
    - c. Globe Fire Sprinkler Corp.
    - d. Grinnell.
    - e. Hammond.
    - f. Milwaukee.
    - g. Nibco.
    - h. Victaulic.

2. 2-1/2-Inch and Larger: Cast iron, flanged, IBBM gate, or butterfly valves.
3. 2 Inches and Smaller: Bronze gate valves.
4. UL 262.

C. Sectional Control Valve(s):

1. Manufacturer: East Jordan Iron Works Series A18; or equal.
2. Gate valve with nonrising stem, mechanical joint 1 end and flanged joint opposite end.
3. Provide three-section cast iron adjustable valve box and cover at grade.

D. Post Indicator Valve(s):

1. Manufacturer: Kennedy Valve Figure 71X; or equal by Nibco, Stockham, or Victaulic.
2. Gate valve with cast iron body mechanical joint ends, bronze mounted, nonrising stem and parallel seats.
3. Provide indicator post equal to Kennedy Figure 541 or Victaulic Series 774 complete with wrench for each post.
4. Provide with flanged ends with indicator reading "Open" or "Closed", extension section as required for mounting height of 30 inches aboveground, angle wrench, counterclock-wise opening, painted fire protection red.
5. Valves to be factory tapped for supervisory switch. Fire Protection Contractor shall provide and install supervisory switches on all valves (switches to be approved type).

E. Swing Check Valve(s):

1. Manufacturer: Viking Models D-1 (2-1/2-inch), D-2 (4-inch), E-2 (8-inch); or equal by Clow, Crane, Grinnell, Hammond, Stockham or Victaulic.
2. Bosses Tapped:
  - a. 1/2-inch for 2-1/2-inch through 4-inch sizes.
  - b. 3/4-inch for 6-inch through 8-inch sizes.
3. UL 312.
4. Valve with ductile iron body, steel hand hole cover, stainless steel clapper, brass seat, rubber faced clapper.
5. Flanged or groove end connections.

## 2.5 ALARMS

A. Manufacturers:

1. Potter Electric Signal.
2. System Sensor.
3. Kennedy.
4. Viking.
5. Grinnell.

B. Flow Switch(es):

1. Viking Model VSR-F (2-inch to 8-inch); or equal.
2. Paddle type, 120V-1 phase, 2 SPDT switches.
3. Furnish and installed by Subcontractor. Wiring and connection to alarm bell and building alarm system by electrical subcontractor.
4. All wiring and connection to building fire alarm panel by electrical Subcontractor.

C. Valve Supervisory Switches: UL 753.

1. Gate Valve Supervisory Switches: Sprinkler Subcontractor to furnish and install gate valve and post indicator valve supervisory switches on all shut-off valves and gate valves in the Sprinkler System. Coordinate switches with fire alarm/electrical contractor to integrate into fire alarm system as required.

PART 3 - EXECUTION

3.1 PREPARATION

A. System Layout:

1. The extent of sprinkler systems and general arrangements of overhead piping and underground piping shall be as indicated on approved Shop Drawings.
2. Deviations there from may be made as required by inspection agencies, insuring agencies or as required due to interference with other equipment, structural members, ducts, etc., and shall be at no additional cost to Owner.
3. Provide additional heads as may be required for an approved system.
4. Distance from sprinkler to wall shall not exceed 1/2 of the allowable distance between sprinklers.
5. Small room rule: Small room rule may be executed when occupancy hazard has been determined as light hazard, unobstructed construction exists and the room does not exceed 800 square feet.
6. Shafts:
  - a. Install 1 sprinkler at the top of the shaft, except if noncombustible, non-accessible duct shaft, electrical shaft or pipe shaft:
    - 1) If combustible surfaces, install sprinkler at each alternate floor level.
    - 2) If accessible and noncombustible, install one sprinkler at top and bottom.
  - b. Elevator Shafts: Sprinkle at the bottom of elevator shaft so it does not get the cab electricals wet. NFPA 13, 2013, Paragraph 8.15.5.1 indicates placing the head not more than 2'-0" above pit floor. Sprinkler system must have a readily accessible shutoff valve (cannot be in a locked room) that is electronically supervised.
7. Stairways: Sprinkler shall be located beneath all stairways of combustible construction:
  - a. If noncombustible shaft, provide sprinkler at the top of the shaft and under first landing.
  - b. If landing is serving 2 or more separate fire divisions, locate sprinklers at the same level as the landing and as required at each landing.
8. Building Service Chute: Sprinklers are required above top service opening, above lowest service opening, and above service openings at alternate levels in buildings over two stories.
9. Dry sidewall sprinkler in unheated spaces.

B. Conflicts:

1. Report discrepancies or conflicts discovered to Engineer.
2. Do not proceed with work until a satisfactory resolution is found.
3. No additional compensation will subsequently be made interferences due to Contractor's negligence, error, oversight or other cause in not having properly established the elevations of all new or existing piping.

C. Access and Protection: Notify General Contractor of any parts of the system requiring additional measures to provide access or to protect from freezing or damage.

3.2 APPLICATION SCHEDULE

Application Schedule				
	Application	Design Temperature Range	Maximum Pressure	Acceptable Pipe/Coupling (See Note Below)
1.	Wet pipe sprinklers	-30 to 230 degrees F	300 psig	A
Note - Pipe/Coupling Types:				
A.	Standard weight steel pipe.			

3.3 INSTALLATION

A. Sprinkler Heads:

1. Location:
  - a. Locate sprinkler heads in suspended ceilings symmetrical with lights, diffusers, and ceiling tile layout. Conceal piping in ceiling space.
  - b. Locate sprinkler heads in the center of lay-in ceiling tiles.
  - c. Head locations must be reviewed by Architect and Engineer prior to installation.

- d. Identify to Contractor any heads that may become subject to freezing or damage.
  2. Special Coatings for Sprinkler Heads:
    - a. Install listed corrosion-resistant sprinklers in locations where chemicals, moisture, or other corrosive vapors sufficient to cause corrosion of such devices exist.
    - b. Corrosion-resistant coatings shall be applied only by the Manufacturer of the sprinkler:
      - 1) Exception: All damage to the protective coating occurring at the time of installation shall be repaired at once using only the coating of the Manufacturer of the sprinkler in the approved manner so that no part of the sprinkler will be exposed after installation has been completed.
    - c. Non-Corrosive Environments:
      - 1) Unless applied by the Manufacturer, sprinklers shall not be painted, and all sprinklers that have been painted shall be replaced with new listed sprinklers of the same characteristics, including orifice size, thermal response, and water distribution. Exception: Factory-applied paint or coating to sprinkler frames shall be permitted in accordance with NFPA 13.
      - 2) Ornamental finishes shall not be applied to sprinklers by anyone other than the sprinkler Manufacturer, and only sprinklers listed with such finishes shall be used.
    - d. Sprinkler heads in foyer shall be mounted in the sidewall of the bulkheads - not exposed.
  - B. Piping:
    1. Piping shall be concealed in areas with ceilings and bulkheads and exposed in areas without ceilings.
    2. Support:
      - a. Piping shall be installed and supported in accordance with NFPA 13 and Michigan Building Code.
      - b. All sprinkler piping shall be supported from the building structure.
      - c. Hanger spacing shall be in accordance with NFPA 13.
      - d. Hanger rod size shall be in accordance with NFPA 13.
      - e. Maximum unsupported length between the end sprinkler and the last hanger shall be in accordance with NFPA 13.
      - f. Cross mains shall be supported by at least 1 hanger between each 2 branch lines.
      - g. As a minimum, risers in buildings with ceilings over 25 feet high shall be supported at each riser pipe section. In multi-story buildings support risers at lowest level, at each alternate level above, below offsets and at the top of risers.
      - h. Hangers in general are covered in NFPA 13. If the system is other than a standard water sprinkler system, the applicable NFPA Standard shall also be consulted.
    3. Cutting and Grooving:
      - a. All flexible pipe fittings including grooved, cut and plain end and all quick fit fittings shall be installed with a machine specifically designed for this purpose.
      - b. All piping to be grooved and cut shall be prepared using this specifically designed machine.
    4. Drainage:
      - a. Install piping to allow for drainage.
      - b. Provide drains at base of risers, on valved sections, at Siamese connections and at other locations for complete drainage of system.
      - c. Pipe drains to floor drain, service sinks, hub outlets or as approved.
    5. Penetrations: Comply with the requirements of Division 21 Section "Penetrations for Fire Suppression" and Division 07 Section "Firestopping."
  - C. Inspectors Test Station:
    1. Provide inspector test connections.
    2. Pipe to outside of building or some other location where water damage will not result.
    3. Automatic Air Vents: Install air vents in accordance with NFPA 13 located near a high point on each system.
- 3.4 PIPING SYSTEM PRESSURE TEST
- A. General:
    1. Perform all tests before piping is painted, covered, concealed or backfilled.
    2. Before testing, remove or otherwise protect from damage, control devices, air vents, fixtures, meters, or other parts which are not designated to withstand test pressures.

- B. Test Procedures:
  - 1. Charge with water to the pressure specified.
  - 2. Exterior Surface of Pipe and Fittings:
    - a. Show no cracks or other form of leaks.
    - b. Completely drip dry.
  
- C. Pressure Test Criteria: Test criteria below are minimum requirements. In addition, the requirements of State and Local Codes having jurisdiction shall be met:
  - 1. Piping System: Water (fire protection).
  - 2. Type Test: Water.
  - 3. Pressure: 200 psig.
  - 4. Allowable Pressure Drop: 0 psi
  - 5. Minimum Test Duration: 2 hours.

### 3.5 PAINTING AND LABELING

- A. Painting of this work is limited to the exposed pipe, fittings and hangers. Do not paint sprinkler heads.
  
- B. Provide labels as specified in Division 21 Section "General Fire Suppression Provisions." Comply with OSHA "Safety Color Code for Marking Physical Hazards".

END OF SECTION 21 10 00

## SECTION 22 05 00 – GENERAL PLUMBING PROVISIONS

### 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 specifying the general requirements for execution of that portion of the Work defined in Division 22 of these Specifications and as indicated on the Drawings:

1. Major items include, but are not necessarily limited to:
  - a. Cutting and patching.
  - b. Concrete foundations and support steel.
  - c. Piping, fittings and valves.
  - d. Piping and equipment insulation.
  - e. Piping and equipment painting.
  - f. Temperature and pressure gages.
  - g. Excavation and backfilling required.
  - h. Plumbing equipment.
  - i. Demolition of existing plumbing work.
  - j. Labor, materials, equipment, tools, supervision and start-up services.
  - k. Instructions to Owner regarding operation.
  - l. Incidental and related items necessary to a complete and functionally operational installation of the Work.

- B. Division of Work: In accordance with the General Conditions, Contractor is responsible for dividing the Work among the Subcontractors and Suppliers and for delineating the Work to be performed by specific trades. The following are suggestions as to how the Work may be divided. This is not a complete list of all the Work:

1. General Contractor:
  - a. Install access doors.
  - b. Provide concrete isolation and housekeeping pads for plumbing equipment.
  - c. Refer to Division 01 Section "Cutting and Patching."
  - d. Provide access doors in walls and ceilings for access to plumbing equipment.
2. Plumbing Subcontractor:
  - a. Refer to Division 01 Section "Cutting and Patching."
  - b. Furnish location, size and quantity of openings to Contractor before construction of new walls, ceilings, and floors.
  - c. Furnish size and locations of concrete equipment isolation and housekeeping pads as required for this Work and as indicated on the Drawings to Contractor before slabs are poured.
  - d. Furnish size and location of access doors required for this work as indicated on the Drawings to Contractor.
  - e. Provide excavation and backfilling required in connection with the Work of Division 22.
  - f. Provide miscellaneous structural steel required in connection with support of the Work of Division 22.
  - g. Perform final cleaning of plumbing systems and equipment.

#### 1.3 REFERENCES

- A. Except as herein specified or as indicated on the Drawings, the work of Division 22 shall comply with the following:
1. ANSI:
    - a. A13.1 - Standard for the Identification of Piping Systems.
    - b. NSF/ANSI 61-2012 – Drinking Water System Components, Health Effects.
    - c. NSF/ANSI 372 – 2011 – Drinking Water System Components, Lead Content.
  2. ASME: B31.9 - Building Services Piping.
  3. ASTM: A325 - Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.

4. EPA: US Safe Drinking Water Act (US SDWA) – 2014.
5. Michigan:
  - a. Rehabilitation Code For Existing Buildings of 2015.
  - b. Plumbing Code of 2021.

#### 1.4 DESIGN AND PERFORMANCE REQUIREMENTS

- A. Construction details, components, accessories, sizes and model numbers indicated on the Drawings or in these specifications are used to indicate minimum levels of quality and coordination requirements.
- B. Equipment supplied, whether as scheduled or selected from list of acceptable Manufacturers, must meet minimum requirements listed in specifications or on Drawings, be compatible with facility and intended use, and meet requirements for a functional system.
- C. Drawings:
  1. Are diagrammatic and indicate general arrangement of systems and work included.
  2. Do not necessarily indicate every required valve, fitting, trap, thermometer, gage, duct, elbow, transition, turning vane, mounting support and access panel.
  3. Shall not be scaled for measurement or installation location.
  4. Shall not serve as Shop Drawings.
- D. Schedules and model numbers shall not be used to:
  1. Serve as final, definitive quantity requirements. Contractor shall make own count as indicated on Drawings.
  2. Determine proper type or model with arrangement, mounting and accessories applicable.
- E. Coordinate installation work of Division 22 with work of other trades to provide a complete and functional system. Generally, the location of ductwork, sanitary, storm and vent piping take precedence over fire protection and HVAC piping, electrical conduit and cable trays.
- F. The Work in Division 22 includes responsibility for supports, braces, etc., and equipment requirements as required to comply with the seismic restraint requirements of the Michigan Rehabilitation Code for Existing Buildings.

#### 1.5 QUALITY ASSURANCE

- A. Comply with all State and Local requirements.
- B. All products and components that conveys or dispenses water for human consumption through drinking or cooking must comply with US SWDA – 2014, NSF 61- 2012, and NSF 372-2011.
  1. Compliance must be certified and labeled by an independent accredited testing agency.

#### 1.6 PRODUCT UNLOADING AND HANDLING

- A. Unload equipment and materials required for completion of the Work.
- B. Handle and store equipment and materials carefully to prevent damage. Method of rigging and handling shall be subject to the approval of an authorized representative of the equipment Manufacturer whose equipment is being handled.

#### 1.7 TROUBLESHOOTING

- A. By Contractor: If, during the start-up or warranty period, mechanical systems operational problems occur for which the root cause is not readily apparent, Contractor shall promptly, through a Subcontractor or other resource designated by Subcontractor, provide diagnostic and investigative services to determine the cause or causes.

- B. By Engineer:
  - 1. At Contractor's request, Engineer will provide the services necessary to determine the cause or causes of the operational problems.
  - 2. Under the provisions of the General Conditions, Engineer will also provide these services if Contractor fails to respond satisfactorily to operational problems within a reasonable time after written notice from Engineer.
  - 3. If while working at Contractor's request or under the provisions of the General Conditions, Engineer determines that the problems are due to failure of the Work to comply with the requirements of the Contract Documents, Owner will compensate Engineer for additional services and deduct the amount paid from payment or payments to Contractor.

## 1.8 MAINTENANCE

- A. Special Tools: Where special tools are required for operation, furnish these to Owner.
- B. Loose and Detachable Parts:
  - 1. Retain loose and small detachable parts of the apparatus and equipment furnished until the completion of the Work.
  - 2. Turn over these parts to Owner.
- C. Construction Strainers:
  - 1. Remove after flushing and cleaning and prior to turn over to Owner.
  - 2. Attach removed construction strainer to piping where removed as proof of removal.

## PART 2 - PRODUCTS

### 2.1 FABRICATIONS

- A. Miscellaneous Structural Steel:
  - 1. Comply with the requirements of Division 05 Section "Metal Fabrications," where applicable.
  - 2. Structural steel work shall be done in accordance with the AISC Specification for Design, Fabrication and Erection of Structural Steel for Buildings, except that allowable stresses shall be reduced 25%.
  - 3. Where required, high strength structural steel bolting conforming to ASTM Specification A325 and assembled to AISC "Specifications for Assembly of Structural Joints. Using High Strength Steel Bolts" or welding shall be used in place of rivets.
  - 4. Connections shall be properly designed for the type of connection and the loads to be carried, and shall be subject to Engineer's or Owner's approval.
  - 5. Welding shall be done by operators who have been previously qualified by tests as prescribed in the American Welding Society "Standard Qualification Procedure" to perform the type of work required.
  - 6. Welding techniques shall conform to the American Welding Society "Code for Arc and Gas Welding in Building Construction", Section 4, Workmanship.
  - 7. Finished members shall be true to line and free from twist, bends and open joints.
- B. Material installed in a ceiling plenum shall be either noncombustible or have a maximum flame spread of 25 and a maximum smoke developed rating of 50.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Character of Work: Installation shall be executed in a workmanlike manner and shall present a neat mechanical appearance when completed.
- B. Laying Out of Work:
  - 1. Layout piping, equipment and components in accordance with the Contract Documents and the Manufacturer's recommended practice, including provision of adequate space for maintenance. Review layout with Engineer prior to installation.



2. Check drawings of other trades to verify spaces in which work will be installed. Maintain maximum head room and space conditions at all points. Where head room or space conditions appear inadequate, notify Engineer before proceeding with installation.
3. If directed by Engineer, Contractor shall make reasonable modifications in the layout as required to permit proper execution of the Work and to prevent conflict with work of other trades.
4. Work shall be installed so as to be ready for operation, maintenance and repair. Minor deviations from Drawings may be made to accomplish this. Changes shall not be made without approval of Engineer.

### 3.2 EXCAVATING AND BACKFILLING

- A. Backfill shall be MDOT Class II sand backfill. The use of clay, stone, rocks, brickbats, cinders, or frozen sand for backfill will not be permitted.
- B. Backfill and fill below structures and pavements shall be compacted to 95% density as determined by ASTM modified proctor.
- C. Pipe Bedding Material Shall:
  1. Conform with Manufacturer's recommendations.
  2. Be MDOT Class II modified to maximum size of 3/8 inches and compacted to 95% density as determined by ASTM modified proctor; or pea gravel with best compaction possible to provide firm continuous support.
  3. Run full width of trench from minimum 4 inches below pipe to 12 inches above pipe.

### 3.3 MODIFICATIONS TO EXISTING FACILITIES

- A. Prior to making connections to existing piping for reuse, confirm that existing piping being tied into is active for reuse.
- B. Comply with the requirements of Division 02 Section "Selective Demolition," for all work related to the modification, alteration, conversion, renovation, and reuse of existing facilities.

### 3.4 PIPE FITTINGS

- A. Provide insulating couplings or unions where dissimilar materials are joined.
- B. Provide unions at valves and at equipment for making repairs.

### 3.5 PAINTING

- A. Paint exposed, insulated and non-insulated piping and equipment, in accordance with the requirements of Division 09 – Finishes.
- B. Provide labels as specified below. Comply with OSHA "Safety Color Code for Marking Physical Hazards" and ANSI A13.1 for pipe labels and colors.
- C. Valves, Fittings, and Supports:
  1. Paint valves and fittings the same base color as the pipe they adjoin.
  2. Paint floor stands the same base color as the pipe they adjoin.
  3. Paint wall brackets and pipe hangers the same base color as the wall or ceiling they adjoin, or gray, if wall or ceiling is not painted.

### 3.6 CODING AND TAGGING

- A. Piping:
  1. Applied to new piping after installation, insulation, and final painting.
  2. Conform to Owner's existing standards or conventions.
  3. Markings:
    - a. Painted on, 1-inch high black letters.
    - b. Color coded band, conforming to ANSI A13.1.

- c. Directional arrow.
    4. Place markers at 20-foot centers with at least 1 in each room, and at every change in direction.
    5. Plastic coated "Set Mark-Snap-Around" pipe markers manufactured by Seton Name Plate Corp., New Haven, Connecticut; or approved equal, may be used in lieu of painted markers and bands.
  - B. Valves:
    1. Provide brass or minimum 1/16-inch thick laminated plastic tags indicating assigned valve number on valves.
    2. Furnish schedule(s) of tagged valves with number, location and purpose of each valve.
    3. Place a copy of each schedule in the Maintenance Instructions.
  - C. Where valves are located above the ceilings, a cadmium plated screw or such marking as designed by Engineer shall be located in the ceiling tile directly below the device.
- 3.7 START-UP
- A. Comply with the requirements of Division 01 Section "Starting and Adjusting."
- 3.8 ADJUSTING
- A. Adjust and align equipment for smooth operation:
    1. Plumb true and with parts in proper position and alignment.
    2. Rotating parts shall turn freely and in the correct direction.
    3. Flexible couplings shall be checked for alignment subject to Owner's approval.
    4. Follow Manufacturer's instructions.
  - B. The work of installation shall be executed in conformity with the best practice, so as to contribute to efficiency of operation, minimum noise or vibration, minimum maintenance, accessibility and sightlines.
- 3.9 FIELD QUALITY CONTROL
- A. Manufacturer's Field Services:
    1. Provide when required by individual Section.
    2. Provide the following services except where indicated otherwise in individual Sections:
      - a. Inspect, check and approve system installation.
      - b. Supervise system start-up.
      - c. Provide written report indicating that system:
        - 1) Has been properly installed and lubricated.
        - 2) Is in accurate alignment.
        - 3) Is free from undue stress imposed by connecting lines or anchor bolts.
        - 4) Has been satisfactorily operated under full load conditions.
      - d. Demonstrate operation of system to Owner's personnel.
      - e. Instruct Owner's personnel on operation and maintenance of system.
  - B. Performance Test:
    1. Test the entire Work, including all of its individual systems for 2 weeks before final payment will be made.
    2. Every phase of plumbing plant shall be operated separately, or in conjunction one with the other to demonstrate to Engineer the ability of the plant to meet capacity and performance requirements while maintaining design condition, in accordance with the true intent and purpose of these Specifications.
    3. Make final tests in the presence of Owner and Engineer.
    4. If a part of the Work or equipment does not meet Specifications:
      - a. Correct the situation.
      - b. Obtain approval of Engineer before final payment is made.
    5. Provide the personnel and bear costs for correcting malfunctions.
    6. Owner will provide operating personnel and utilities.
  - C. Comply with the requirements of Division 01 Section "Starting and Adjusting."

3.10 CLEANING AND FINISHING

- A. Comply with the requirements of Division 01 Section "Cleaning and Waste Management."
- B. Entire installation shall be free from surface oil and grease before work will be considered for final payment.
- C. After tests have been made and the system pronounced tight:
  - 1. Clean piping and equipment.
  - 2. Lubricate bearings.
- D. Final cleaning includes but is not limited to the following:
  - 1. Equipment with Factory Finishes:
    - a. Wash factory-finished equipment with mild soap and water and leave in first-class condition, entirely free of stains or streaks.
    - b. Do not use abrasive materials. Touch up scratches or other violations of the factory finish paint with matching paint from the equipment Manufacturer prior to cleaning.
  - 2. Plumbing Fixtures:
    - a. Clean with mild soap and water containing a disinfecting agent.
    - b. Set trim handles at same angle and polish.
    - c. Remove, clean and reinstall aerators.
    - d. Check pop-up wastes for proper operation.
  - 3. Clean sumps, pits, trenches, manholes, catch basins and floor drains and leave free of foreign material.

END OF SECTION 22 05 00

## SECTION 22 05 03 – STEEL PIPE AND FITTINGS FOR PLUMBING

### 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 basic requirements of steel pipe and fittings. Refer to Division 22 Section “Plumbing Piping and Specialties” for project specific requirements.

#### 1.3 REFERENCES

- A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with the following:
  - 1. American Society of Mechanical Engineers (ASME) Standards:
    - a. B16.3 - Malleable Iron Threaded Fittings.
    - b. B16.4 - Cast-Iron Threaded Fittings, Class 125 and 250.
    - c. B16.5 - Pipe Flanges and Flanged Fittings, Steel Nickel Alloys and Other Special Alloys.
    - d. B16.9 - Factory-Made Wrought Steel Butt Welding Fittings.
    - e. B16.11 - Forged Steel Fittings, Socket Welding and Threaded.
    - f. B16.21 - Nonmetallic Flat Gasket for Pipe Flanges.
    - g. B18.2.1 - Square and Hex Bolts and Screws, Inch Series.
    - h. B18.2.2 - Square and Hex Nuts.
    - i. B31.9 - Building Services Piping.
  - 2. ASME Publications:
    - a. Boiler and Pressure Vessel Code.
    - b. Heating Boiler Code.
  - 3. ASTM Standards:
    - a. A53 - Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
    - b. A105 - Forgings, Carbon Steel, for Piping Components.
    - c. A106 - Seamless Carbon Steel Pipe for High-Temperature Service.
    - d. A126 - Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
    - e. A181 - Forgings, Carbon Steel for General Purpose Piping.
    - f. A197 - Cupola Malleable Iron.
    - g. A234 - Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
    - h. A269 - Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
    - i. A 307 - Carbon Steel Bolts and Studs, 60,000 psi Tensile.
    - j. A312 - Seamless and Welded Austenitic Stainless Steel Pipe.

#### 1.4 SUBMITTALS

- A. Submit Shop Drawings and Manufacturer's Literature: For steel pipe and fittings. Include Manufacturer name, Manufacturer location, dimensions, and details of construction and installation.

#### 1.5 QUALITY ASSURANCE

- A. Fabrication and Installation Personnel Qualifications:
  - 1. Trained and experienced in the fabrication and installation of the materials and equipment.
  - 2. Knowledgeable of the design and the reviewed Shop Drawings.
- B. Labeling: Piping materials shall bear the label, stamp or other marking of all specified standards and testing compliance, visible on the outside of the bare pipe.

- C. Testing of Steel Piping: In accordance with Division 22 Section "Testing and Cleaning of Plumbing Systems."

## PART 2 - PRODUCTS

### 2.1 MATERIALS

#### A. General:

1. Except as herein specified or as indicated on the Drawings, all materials shall be in accordance with the Piping Systems Schedule in Part 3 of the appropriate applicable specification section.
2. Pipe 6'-0" and longer shall be permanently marked, visible on the outside of the bare pipe, with the following information:
  - a. Manufacturer's name.
  - b. Pressure rating.
  - c. Standards met.
  - d. Size.
3. All pipe joints shall be welded for pipe sizes 2-1/2 inches and larger.

#### B. Black Steel Pipe:

1. Black steel pipe shall be welded or seamless carbon steel, as specified for the type of service.
2. Welded black steel pipe shall meet the requirements of ASTM A53 or A106, and shall be Type F continuous-weld furnace butt-welding (CW), or Type E electric resistance welded (ERW) Grade B.
3. Seamless black steel pipe shall meet the requirements of ASTM A53 or A106, Type S seamless, Grade A or B.

#### C. Buried Piping:

1. Wrap with a pressure sensitive, adhesive backed, polyvinyl chloride or polyethylene tape:
  - a. Spirally wrap straight pipe with 0.020-inch thick tape with minimum overlap of 1/2-inch.
  - b. Spirally wrap 2 layers of 0.010 thick tape with minimum overlap of 1/2-inch.
  - c. Manufacturers: 3M Company "Scotchwrap"; or approved equal.
2. Steel pipe with a factory applied polyethylene plastic coating such as Energy Coatings Company, "Pritec" may be used in lieu of wrapping specified above.

### 2.2 FITTINGS

#### A. Unions:

1. Pipe Sizes 2 Inches and Smaller :
  - a. Forged steel with ground joint.
  - b. Properly fitted for design temperature and pressure.
  - c. 2,000-pound rated equal to Crane No. 250H or 251H.
  - d. 3,000-pound rated equal to Crane No. 252H.
2. Pipe Sizes 2-1/2 Inches and Greater: Use companion flanges where unions are required.

#### B. Tapped Bosses:

1. Permitted in pipes and fittings.
2. 1-1/2-inch maximum hole size.
3. Boss Construction:
  - a. Weld material built up to a thickness 50% greater than required threads.
  - b. Forged bosses as approved by Engineer.
  - c. 300 pound rated half couplings welded to pipe permitted for instrument connections 3/4-inch or smaller.

#### C. Screwed Fittings:

1. Cast Class 300 iron in accordance with ASME B16.4.
2. Nodular or ductile iron in accordance with ASTM A395.

#### D. Welding Fittings:

1. Meet ASTM A234 symbol WPA or WPB.
2. The A or B grade shall conform to the grade of pipe used with the fittings.
3. Dimensional standards shall conform to ASME B16.9.

- E. Flanges:
  - 1. General:
    - a. Welding neck or slip-on type with raised face.
    - b. Conforming to ASME B16.5.
    - c. Class 150 and 300 conforming to ASTM A181, Grade I.
    - d. Class 600 and 900 conforming to ASTM A105, Grade II.
  - 2. Use threaded or socket weld type for piping smaller than 2-1/2 inches.
  - 3. Use flat face steel flanges when matching cast iron companion flanges.
  
- F. Flange Gaskets:
  - 1. Non-asbestos compressed material conforming to ASME B16.21 and suitable for 600 degrees F service.
  - 2. Ring type, 1/16-inch thickness.
  - 3. Spiral wound stainless steel for service over 300 psi.
  - 4. Use full face gaskets with flat face flanges.
  
- G. Bolting Material:
  - 1. General:
    - a. Carbon steel, square-head bolts and Grade 2H hex nuts.
    - b. Bolt length shall be sufficient to extend completely through nut with maximum 3/8-inch projection.
    - c. Dimensions conforming to ASME B18.2 (bolts) and ASTM A194 (nuts).
  - 2. Bolts:
    - a. For service below 250 psig/450 degrees F, use Grade B conforming to ASTM A307.
    - b. For service at or above 250 psig/450 degrees F, use Grade B7 conforming to ASTM A193.
  
- H. Socket Welding Fittings: All forged steel socket-welding fittings shall conform to ASME Standard B16.11 ASTM A105 Gr. II, equal to Crane 3,000-pound forged fittings.

## 2.3 MECHANICAL PIPING COUPLINGS

- A. Manufacturers:
  - 1. Victaulic.
  - 2. Anvil.
  
- B. General:
  - 1. All grooved piping materials shall conform with the specifications governing the systems or application for which they are used.
  - 2. All couplings and fittings shall be finished with hot-dip galvanizing of alkyd enamel paint.
  
- C. Pipe and Tubing:
  - 1. Standard Weight Steel Pipe:
    - a. Comply with the requirements of Division 22 Section "Steel Pipe and Fittings for Plumbing."
    - b. ASTM Schedule 40, A53 black steel or hot-dipped zinc-coated and seamless .
  
- D. Couplings:
  - 1. Housing: Standard Steel Pipe: Ductile iron, ASTM A536.
  - 2. Style: Standard Steel Pipe:
    - a. Rigid style.
    - b. Victaulic "Zero-Flex" style 07.
  - 3. Gasket:
    - a. Water Service: EDPM.
    - b. Chemical Service: VITON.
    - c. Oil, Air and Vacuum Service: Nitrile.
  - 4. O-rings (Thin Wall Only):
    - a. Water Service: Grade C butylenes.
    - b. Chemical Service: Not acceptable.
    - c. Oil Service: Not acceptable.
    - d. Air and Vacuum Service: Not acceptable.

5. Bolts – Nuts:
  - a. Track bolts with 110,000 psi tensile strength.
  - b. Heavy hex nuts.
  - c. Zinc electroplated carbon steel.
  
- E. Fittings:
  1. Steel, ductile iron, copper or bronze.
  2. Grooves or shoulders compatible with system couplings.
  3. Segmentally welded fittings not acceptable.
  4. Clamp-on mechanical tees accepted.
  
- F. Valves:
  1. Refer to Division 22 Section “General Duty Valves for Plumbing,” or specification section governing the system or application for which they are used.
  2. Compatible with grooved pipe coupling.
  
- G. Strainers:
  1. Refer to Division 22 Section “Plumbing Piping and Specialties.”
  2. Compatible with grooved pipe coupling.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. During Freezing Weather:
  1. Protect all materials in such a manner that no harm can be done to:
    - a. Installations already made.
    - b. Materials and equipment on the Site.
  2. Furnish all necessary protection for such installations and equipment as may be required.

### 3.2 ERECTION

- A. General:
  1. All Piping: Follow approved paths as indicated on the Drawings.
  2. Connect to existing lines where required, or to equipment in an approved manner.
  3. Locate Pipes, Valves and Equipment to Provide:
    - a. Access for maintenance.
    - b. Minimum obstruction of passageways and working space.
  4. Normally, all pipe runs shall be plumb, parallel with the building and level, except for drain slope.
  5. Be responsible for establishing and maintaining drain slope of piping in order to ensure drainage.
  6. Expansion of Piping:
    - a. All pipe connections shall provide freedom of movement of the piping during expansion and contraction without springing of piping or injury to building steel or structure.
    - b. Any damage to building steel or structure as a result of work installed by Contractor shall be repaired at Contractor's expense.
  7. As Piping Material is Erected:
    - a. Thoroughly clean the inside of all piping.
    - b. Remove foreign material such as scale, sand, weld spatter, particles and cutting chips.
  8. Provide caps or plugs in all openings at the end of each day's work and as otherwise directed for the protection of the piping. Particular attention must be given to avoid the possibility of any foreign material entering the pipes.
  9. Flanges shall be made on pipe so that the gasket surface forms an angle of 90 degrees with the pipe axis. Screwed flanges shall be made on until the pipe projects through the flanges and then the flanges must be refaced.
  
- B. Sleeves and Holes:
  1. Contractor shall be responsible for cutting required holes and openings in floors, walls and other structures, except as noted on the Drawings. Sleeves will be placed by Contractor in all such openings,

and no holes shall be cut without Owner's approval. Sleeves shall be in accordance with the standard details included in the Drawings.

2. All holes in floors, walls, roofs, etc., where pipe lines or other materials have been removed or installed, shall be neatly and properly filled with concrete, brick or other material in accordance with the general character of the construction at the location.

C. Unions and Eccentric Fittings:

1. Unions shall be provided at each screwed valve and where their use will facilitate dismantling of the piping and as required or directed in special cases.
2. Eccentric fittings or eccentric reducing couplings shall be provided in all cases where air or water pockets would otherwise occur in the main due to the reduction in pipe size.
3. All reducing fittings used at pump inlets shall be eccentric and flush on the top for hydronic piping.
4. Eccentric fittings shall keep the pipes flush on the bottom for steam and condensate piping.

D. Pipe Joints:

1. Pipe connections at all valves shall be mechanically joined unless otherwise indicated on the Drawings or reviewed by Owner or Engineer.
2. Pipe joints which will be buried or otherwise concealed shall be welded regardless of size.
3. Mitered joints shall not be permitted.
4. In general, black steel 2-1/2-inch and larger shall be welded except that a flange or union shall be provided at all valves and at equipment.
5. The connections to welded 2-1/2-inch and larger pipe shall be made with a welding tee or Weld-o-let of butt, socket or threaded type as required. Scarf welding of side connections shall not be permitted.
6. Only welding ells shall be used for changing pipe directions of welded pipe lines.

E. Pipe Welding:

1. Where welding is called for, it shall be of the fusion process and shall consist of welding by means of either the oxyacetylene or electric arc process.
2. All welding shall conform to the ASME Boiler and Pressure Vessel Code. All welders shall be qualified in accordance with ASME Standard Qualifications for Welding Procedures, Welders and Welding Operators, or Section 9 of the ASME Boiler and Pressure Vessel Code for the class of piping being welded. Submit welding qualifications for all welders on the Project when requested by Engineer.

### 3.3 MECHANICAL COUPLING SYSTEMS

- A. Piping shall be prepared in accordance with the latest Manufacturer's specifications or other standards applicable.
- B. Standard weight (Schedule 40 or heavier) steel piping may be roll grooved or cut grooved.
- C. Couplings, fittings, valves and pipe shall be assembled in accordance with latest Manufacturer's instructions.
- D. Support piping according to Manufacturer's maximum span recommendations or Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment," whichever is more stringent.
- E. Raised face flanges shall have a metal flange washer installed.
- F. Cutting, Grooving and Crimping:
  1. All flexible pipe fittings including grooved, cut and plain end and all quick fit fittings shall be installed with a machine specifically designed for this purpose.
  2. All piping to be grooved, cut and crimped shall be prepared using this specifically designed machine.
- G. Mechanical joints are not allowed within walls.



3.4 APPLICATION SCHEDULE

Application Schedule				
Application	Design Temperature Range	Maximum Pressure	Acceptable Pipe/Coupling (See Note Below)	
Sanitary drain and vent	-30 to 230 degrees F	300 psig	A	B
Note – Pipe/Coupling Types:				
A. Standard weight steel pipe.				
B. Copper Tubing: Refer to Section 22 05 09 – Copper Pipe and Fittings for Plumbing.				

3.5 ADJUSTING AND CLEANING

- A. Clean and test piping in accordance with Division 22 Section “Testing and Cleaning of Plumbing Systems.”

END OF SECTION 22 05 03

## SECTION 22 05 06 – CAST IRON PIPE AND FITTINGS FOR PLUMBING

### 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 basic requirements of all cast iron pipe and fittings. Refer to Division 22 Section "Plumbing Piping and Specialties" for project specific requirements.

#### 1.3 REFERENCES

- A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with the following:
  - 1. ASTM Specifications:
    - a. A74 - Hub and Spigot Cast Iron Soil Pipe and Fittings.
    - b. A888 - Hubless Cast Iron Soil Pipe and Fittings.
    - c. C564 - Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
    - d. C1277 – Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings.
  - 2. Cast Iron Soil Pipe Institute (CISPI) Specification:
    - a. 301 - Cast Iron Soil Pipe and Fittings for Hubless Cast Iron Sanitary System.
    - b. 310 - CISPI's Patented Joints for Use in Connection with Hubless Cast Iron Sanitary System.
  - 3. AWWA Standard:
    - a. Couplings for Use in Connection with Hubless Cast Iron Pipe and Fittings for Drain, Waste and Vent Piping Applications.
    - b. C110 - Gray-Iron and Ductile-Iron Fittings, 3 inches through 48 inches, for water and other liquids.
    - c. C111 - Rubber Gasketed Joints for Ductile-Iron Pressure Pipe and Fittings.
    - d. C151 - Ductile Iron Pipe Centrifugally Cast in metal Molds or Sand Lined Molds for water or other liquids.
    - e. C153 - Ductile Iron Compact Fittings, 3-inch through 24-inch.

#### 1.4 SUBMITTALS

- A. Submit in accordance with Division 01 Section "Submittal Procedures."
- B. Manufacturer's Literature: For cast iron pipe and fittings and couplings. Includes Manufacturer name, Manufacturer location, dimensions, and details of construction and installation.

#### 1.5 QUALITY ASSURANCE

- A. Fabrication and Installation Personnel Qualifications:
  - 1. Trained and experienced in the installation of the material.
  - 2. Knowledgeable of the design and the reviewed Shop Drawings.
- B. Regulatory Requirements: Comply with local code applicable to installation of the material.

### PART 2 - PRODUCTS

#### 2.1 HUB AND SPIGOT PIPE AND FITTINGS

- A. ASTM A74, Service class.

- B. Gaskets:
  - 1. ASTM C 564.
  - 2. Elastomeric double seal compression type.
- C. All pipe and fittings shall be made in the United States and bear the CISPI trademark.

## 2.2 HUBLESS PIPE AND FITTINGS

- A. ASTM A888 and CISPI 301.
- B. Couplings:
  - 1. ASTM C1277 Couplings.
  - 2. ASTM C1540 Heavy Duty Couplings.
  - 3. Corrosion resistant fasteners.
  - 4. ASTM C564 rubber sleeve with integral, center pipe stop.
  - 5. Above Ground or Corrosive Soils:
    - a. Heavy Duty, Type 304, Stainless Steel Couplings: ASTM A666, Type 304, stainless steel shield; stainless steel bands; and sleeves.
      - 1) NPS 1-1/2 to NPS 4 (DN 40 to DN 100): 3-inch wide shield with 4 bands.
      - 2) NPS 5 to NPS 10 (DN 125 to DN 250): 4-inch wide shield with 6 bands.
    - b. Heavy Duty, Cast Iron Couplings: ASTM A48, 2 piece, cast iron housing; stainless steel bolts and nuts; and sleeve.
  - 6. Below Ground (Non-Corrosive Soils):
    - a. Heavy Duty, Type 301, Stainless Steel Couplings: ASTM A666, Type 301, stainless steel shield; stainless steel bands; and sleeve.
      - 1) NPS 1-1/2 to NPS 4 (DN 40 to DN 100): 3-inch wide shield with 4 bands.
      - 2) NPS 5 to NPS 10 (DN 125 to DN 250): 4-inch wide shield with 6 bands.
- C. All pipe and fittings shall be made in the United States and bear the CISPI trademark.

## PART 3 - EXECUTION

### 3.1 ERECTION

- A. System shall be installed in accordance with Manufacturer's instructions and Code requirements.
- B. Hubless piping shall not be used for pressurized applications.

### 3.2 JOINTS AND FITTINGS

- A. Mitered joints will not be permitted.
- B. Joints between CI soil pipe and "DWV" (drain, waste and vent) copper pipe are to be made with calking ferrule for bell and spigot pipe or a compatible adapter for hubless pipe.
- C. Pipe and fittings shall be joined by 1 of the following 3 methods:
  - 1. Calked lead and oakum.
  - 2. Positive double seal elastomeric compression type gasket.
  - 3. No hub clamp assembly.
- D. Service weight pipe shall be joined with service weight gasket.
- E. Use extra heavy gasket with extra heavy pipe.

END OF SECTION 22 05 06

## SECTION 22 05 09 – COPPER PIPE AND FITTINGS FOR PLUMBING

### 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 basic requirements of copper pipe and fittings. Refer to Division 22 Section "Plumbing Piping and Specialties" for project specific requirements.

#### 1.3 REFERENCES

- A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with the following:
  - 1. ASTM Specifications:
    - a. B75 - Copper Fittings.
    - b. B88 - Seamless Copper Water Tube.
    - c. B306 - Copper Drainage Tube (DWV).
  - 2. ANSI Publications: A13.1 - Scheme for the Identification of Piping Systems.

#### 1.4 SUBMITTALS

- A. Manufacturer's Literature: Include material, properties, dimensions, details of construction and installation, name of Manufacturer.

#### 1.5 QUALITY ASSURANCE

- A. Fabrication and Installation Personnel Qualifications:
  - 1. Trained and experienced in the fabrication and installation of the materials and equipment.
  - 2. Knowledgeable of the design and the reviewed Shop Drawings.
  - 3. Installer of mechanical coupling piping system must be able to demonstrate a minimum of 5 years successful installation experience.
- B. Testing of Copper Piping: In accordance with Division 22 Section "Testing and Cleaning of Plumbing Systems."

#### 1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials in original, unbroken, brand marked containers or wrapping as applicable.
- B. Handle and store materials in a manner which will prevent deterioration and contamination with foreign matter.
- C. Reject damaged, deteriorated, or contaminated material and immediately remove from the Site. Replace removed materials at no additional cost to Owner.

### PART 2 - PRODUCTS

#### 2.1 PIPING MATERIALS

- A. Seamless Copper Tubing:
  - 1. Factory coded and marked.

2. Conform to the following schedule:
    - a. Aboveground: ASTM B88, Type L or K, hard drawn.
    - b. Buried: ASTM B88, Type K soft temper.
    - c. Drainage: ASTM B306, Type DWV.
  3. Pipe Markings:
    - a. All piping longer than 2'-0" shall have a permanent marking in accordance with ASTM or ANSI specifications.
    - b. This identification shall include the following:
      - 1) Manufacturer's name.
      - 2) Pipe pressure rating.
      - 3) Pipe size.
- B. Solder type shall conform to the following:
1. Hot and cold water and recirculation lines smaller than 2 inches: 95% tin, bismuth, copper and 5% silver.
    - a. IAPMO listed lead free.
  2. Hot and cold water and recirculation lines 2 inches and larger:
    - a. Silver Braze.
    - b. IAPMO listed lead free.
  3. Drain Piping: 50% tin and 50% lead.
  4. Condensate Drain Piping: 50% tin and 50% lead.
- C. Fittings:
1. General Service:
    - a. Sweat type, wrought copper, long radius elbows.
    - b. Cast fittings shall only be allowed with written permission from the Engineer.
  2. Drainage:
    - a. Sweat type, wrought copper, drainage pattern.
    - b. Specialty items, such as closet elbows, may be cast brass.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. During Freezing Weather:
1. Protect all materials in such a manner that no harm can be done to:
    - a. Installations already made.
    - b. Materials and equipment on the Site.
  2. Furnish all necessary protection for such installations and equipment as may be required.

### 3.2 ERECTION

- A. General:
1. All Piping: Follow approved paths as indicated on the Drawings.
  2. Connect to existing lines where required, or to equipment in an approved manner.
  3. Locate Pipes, Valves and Equipment to Provide:
    - a. Access for maintenance.
    - b. Minimum obstruction of passageways and working space.
  4. Normally, all pipe runs shall be plumb, parallel with the building and level, except for drain slope.
  5. Be responsible for establishing and maintaining drain slope of piping in order to ensure drainage.
  6. Expansion of Piping:
    - a. All pipe connections shall provide freedom of movement of the piping during expansion and contraction without springing of piping or injury to building steel or structure.
    - b. Any damage to building steel or structure as a result of work installed by Contractor shall be repaired at Contractor's expense.
  7. As Piping Material is Erected:
    - a. Thoroughly clean the inside of all piping.
    - b. Remove foreign material such as scale, sand, weld spatter, particles and cutting chips.
  8. Provide caps or plugs in all openings at the end of each day's work and as otherwise directed for the protection of the piping.

- B. Pipe Joints:
  - 1. Cut ends of copper tubing squarely using only sharp tube cutters.
  - 2. Ream pipe to full I.D. before preparing the joint.
  - 3. Soldering:
    - a. Solder or braze joints by cleaning outside ends of all copper tubings and inside of fittings immediately before joining and soldering.
    - b. Apply solder flux to both tube and fitting.
    - c. Insert tube full depth into fitting, apply heat and solder in such a manner as to draw solder into and completely around the joint.
  - 4. Joining Valves:
    - a. When joining copper lines to valves follow Manufacturer's instructions.
    - b. In general:
      - 1) Valve shall be in the fully open position.
      - 2) Solenoid and expansion valves shall be broken down.

### 3.3 FIELD QUALITY CONTROL

- A. Clean and test piping in accordance with Division 22 Section "Testing and Cleaning of Plumbing Systems."

END OF SECTION 22 05 09

## SECTION 22 05 19 – METERS AND GAGES 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.

#### 1.2 SUMMARY

- A. This Section includes the furnishing and installation of all temperature and pressure gages. Unless otherwise specified, gages shall be as described in this Specification.

#### 1.3 REFERENCES

- A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with the following:
  - 1. ASME Standard:
    - a. B40.1 - Gages - Pressure, Indicating Dial Type - Elastic Element.
    - b. B40.30 - 1990 - Thermometers.

#### 1.4 SUBMITTALS

- A. Manufacturer's Literature: For all gages and thermometers. Include name of Manufacturer, model, dimensions, and scale range.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Ametek.
- B. Ashcroft.
- C. H.O. Trerice.
- D. Miljoco.
- E. Trend Instruments.
- F. Weiss.

#### 2.2 EQUIPMENT

- A. Dial Thermometer:
  - 1. Bimetal type with adjustable dial face.
  - 2. 5-inch diameter dial.
  - 3. 6-inch nominal stem length.
  - 4. Union lock nut.
  - 5. Zero adjustment.
  - 6. Hermetic seal.
  - 7. Equal to H.O. Trerice B85600 Series.

- B. Industrial Thermometer:
  - 1. Aluminum case, acrylic face, adjustable angle, blue spirit filled tubing.
  - 2. 9-inch scale.
  - 3. 3-1/2-inch nominal stem length. (6-inch for pipe sizes 6 inches and over).
  - 4. Equal to H.O. Terice BX91 Series.
  
- C. Pressure Gage:
  - 1. Bourdon tube type or bourdon coil type with direct coupled pointer, liquid filled.
  - 2. 4-1/2-inch minimum diameter.
  - 3. Accuracy of +1% of scale range.
  - 4. Equal to H.O. Terice 450 Series.
  - 5. Liquid fill must be compatible with temperatures in measured fluid.

### 2.3 ACCESSORIES

- A. Thermowell:
  - 1. Provide for all thermometers.
  - 2. 304 stainless steel.
  - 3. Equal to H.O. Terice Cat. No. 138-0015.3 (138.0016.2 for pipe 6 inches and over).
  
- B. Needle Valve:
  - 1. Provide for all pressure gages.
  - 2. Equal to H.O. Terice Series 735.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install all thermometers and pressure gages in conformance with:
  - 1. The Drawings.
  - 2. These Specifications.
  - 3. Manufacturer's recommendations.
  
- B. Support all pressure gages and remote-reading thermometers:
  - 1. With 12-gage formed steel bracket.
  - 2. Secured to structure or equipment.

### 3.2 APPLICATION

- A. Select all dial ranges such that normal operating temperature/pressure measured at point of installation is near mid-range.

END OF SECTION 22 05 19



## SECTION 22 05 23 – GENERAL DUTY VALVES FOR PLUMBING

### 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 furnishing and installation of all valves.

#### 1.3 REFERENCES

- A. Except as specified or as indicated on the Drawings, the work of this Section shall comply with the following:
  1. General: Provide valves with features indicated and, where not otherwise indicated, provide proper valve features as determined by Installer for installation requirements. Comply with ASME B31.9 for building services piping, and ASME B31.1 for power piping.
  2. Flanged: Valve flanges complying with ANSI B16.1 (cast iron), ANSI B16.5 (steel), or ANSI B16.24 (bronze).
  3. Threaded: Valve ends complying with ANSI B2.1.
  4. Solder-Joint: Valve ends complying with ANSI B16.18.
  5. Flangeless: Valve bodies manufactured to fit between flanges complying with ANSI B16.1 (cast iron), ANSI B16.5 (steel), or ANSI B16.24 (bronze).

#### 1.4 DESIGN AND PERFORMANCE REQUIREMENTS

- A. General:
  1. This Section is provided as a guide in the application and specification of specific valves intended for use in this Project. This Section does not instruct where to install these valves unless specifically noted. Refer to other specific Plumbing Specification Sections and Drawing details for instruction for location and use.
  2. As indicated on the Drawings.
  3. As called out in the Piping Systems Schedules.
- B. Valves not specifically indicated on the Drawings:
  1. Size and class of valve to agree with line in which installed.
  2. All valves 2-1/2-inch and larger shall be flanged unless noted otherwise.
  3. All valves 8-inch and larger shall be furnished with suitable bypass valve and piping.
- C. Valves shall have Manufacturer's name, trademark and working pressure rating cast into the valve body.

#### 1.5 SUBMITTALS

- A. Shop Drawings for all valves.
- B. Manufacturer's Literature: For All Valves:
  1. Manufacturer's name.
  2. Details of construction.
  3. Performance characteristics.

#### 1.6 QUALITY ASSURANCE

- A. Made in USA:
  1. Unless specifically noted otherwise, all valves shall comply with the Federal Trade Commission Made in USA standard.
  2. Supplier shall furnish documentation of USA content if requested by Engineer.

- B. Fabrication and Installation Personnel Qualifications:
  - 1. Trained and experienced in the fabrication and installation of the material and equipment.
  - 2. Knowledgeable of the design and the reviewed Shop Drawings.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Valves shall be manufactured by one Manufacturer for each type of valve. Where valve Manufacturers are not specifically indicated, they shall be one of the following:
  - 1. Nibco.
  - 2. Kennedy.
  - 3. Crane.
  - 4. Milwaukee.
  - 5. Keystone.
  - 6. Stockham.
  - 7. Grinnell.
  - 8. Mueller Steam Specialties
  - 9. Jamesbury.
  - 10. DeZurik.
  - 11. Hammond.
  - 12. Apollo.
  - 13. Watts

### 2.2 MATERIALS

- A. Bronze Valves:
  - 1. All brass alloys used in valves shall contain no more than 15% zinc.
  - 2. Alloys must comply with ASTM B61, B62 or B584.

### 2.3 HAND VALVES

- A. General:
  - 1. Provide extended stem handles with a minimum clearance of 1-1/2-inch on insulated service.
  - 2. All valves used for throttling/balancing shall have adjustable memory stops.
  - 3. Pressure ratings are at service indicated by application.
- B. Gate Valves:
  - 1. Gate valves used in connection with piping 2 inches in size and smaller shall be all bronze, union bonnet, rising stems, solid wedge taper seat, screwed or sweat ends and back seat, designed for 125 psi SWP. Valves used for piping 2-1/2-inch in size and larger shall be IBBM, OS&Y, bolted bonnet, rising stem, solid wedge, bronze mounted, flanged ends, and designed for 125 pounds.
  - 2. Based on Nibco T-124 for 2-inch and less, Nibco F-617-O for 2-1/2 inches or larger.
- C. Globe Valves:
  - 1. Threaded end 2-inch and smaller (125 psig and less): 125 pounds wsp, bronze body, rising stem, screwed bonnet, Teflon disc, Crane No. 7TF, or equal.
  - 2. Threaded end 2-inch and smaller (above 125 psig): Class 300, bronze body, rising stem, union bonnet, renewable SS seats, SS disc, Crane No. 382-P; or equal.
  - 3. Solder joint end 2-inch and smaller: 300 CWP, bronze body, rising stem, screwed bonnet, Teflon disc, Crane No. 1310; or equal.
  - 4. Flanged end 2-1/2-inch and larger (125 psig and less): Class 125, iron body, bronze trim, OS&Y bonnet, Crane No. 351; or equal.
  - 5. Flanged end 2-1/2-inch and larger (above 125 psig): Class 250, iron body, bronze trim, OS&Y bonnet, Crane No. 21E; or equal

- D. Ball Valves:
1. Ball valves used in connection with piping 2 inches in size and smaller shall have screwed or sweat ends, 2 piece bronze body, full port with stainless steel ball and a like stem. VA rated for 150 pound SWP and 600 WOG. Seats and seals shall be virgin teflon for standard duty cycle. Provide reinforced teflon for applications identified for extended duty cycle.
  2. 3 inches and larger shall be flanged or butt welded.
- E. Butterfly Valves:
1. Iron body rated for 175 psig and 250 degrees F, bubble-tight shutoff.
  2. Lug body for use with ANSI flanges. Wafer style is not acceptable, except where specifically approved.
  3. Bronze disk, 416 stainless steel shaft, EPDM seat.
  4. Provide neck extended 2 inches beyond flange diameter.
  5. DeZurik Figure BOS-US; or equal.
- F. High Performance Butterfly Valves:
1. Manufacturers: Bray - Braylok Series 41, Dezurik - BHP, Jamesbury - 815L, Milwaukee - HP Series, Tri-Seal Valve-Contromatics (formerly Watts/KF Contromatics), Xomox Pliaseal, ABZ ABZolute Seal Series 400.
  2. Full lug, high performance type, carbon steel body, 316 stainless steel disc, stainless steel shaft and bearing, PTFE seat, Teflon stem packing. Rated for 150 psi, 450 degrees F.
  3. For domestic water systems, full lug, high performance type, 316 stainless steel body, 316 stainless steel disc, stainless steel shaft and bearing, (all wetted parts stainless steel) PTFE seat, Teflon stem packing. Rated for 150 psi, 250 degrees F.
- G. Drain Valves: Furnish at each low point 3/4-inch gate or ball valves as specified above. Install nipple with cap at valve outlet.
- H. Plug Valves:
1. Plug valves shall be nonlubricated eccentric plug type rated for 175 CWP with iron body neoprene coated plug and epoxy coated seat; equal to DeZurik PEC or Homestead Series 300. Furnish with compatible wrench. All valves used for throttling/balancing to have adjustable memory stop.
  2. Plug valves (gas cock) for natural gas shutoff applications shall be lubricated type equal to Homestead Figure 611 or 612 or Rockwell Figure 114 or 115.

## 2.4 CHECK VALVES

- A. Silent Check Valve:
1. Install silent check valves in all pump discharge.
  2. Piping less than 2-inch:
    - a. High temperature, lead-free not required: 300 pounds, bronze body, renewable bronze disc screwed or sweat ends, bronze trim, Mueller, #103-MBP; or equal.
    - b. Lead-free, up to 100°F; Mueller 101MAT or Watts LF600 for applications less than 15 psig.
    - c. Lead-free, up to 250°F: Mueller 103MAT and where lead-free is required.
  3. Piping 2-inch and larger: 125 pounds, globe type, iron body, bronze trim, renewable seat and disc, SS springs, Mueller Steam Specialties, 101MAT, 103MAT; or equal.
- B. Swing Check Valve:
1. 2-Inch and Smaller: 125 psi valves for domestic hot and cold water.
    - a. MSS SP-80; Class 125, cast-bronze body and cap conforming to ASTM B62; with horizontal swing, Y-pattern, and bronze disc; and having threaded or solder ends.
    - b. Provide valves capable of being reground while the valve remains in the line.
    - c. Provide Class 150 valves meeting the above specifications, with threaded end connections, where system pressure requires or where Class 125 valves are not available.
  2. 2-1/2-Inch and Larger for Domestic Hot and Cold Water, Heating Hot Water:
    - a. MSS SP-71; Class 125 cast iron body and bolted cap conforming to ASTM A126, Class B; horizontal swing, and bronze disc or cast-iron disc with bronze disc ring; and flanged ends.
    - b. Provide valves capable of being refitted while the valve remains in the line.

### PART 3 - EXECUTION

#### 3.1 VALVE APPLICATION SCHEDULE

- A. Cold Water, Hot Water and Hot Water Return System:
  - 1. Isolation through 2-inch: Ball Valve.
  - 2. Isolation 2 1/2-inch and Larger: High Performance Butterfly Valve, All stainless steel.
  - 3. Check: Swing Check through 2-inch, Silent Check for 2 1/2-inch and up.
  - 4. Balancing: Thermostatic Balancing Valve, Manual Balancing Valve.

#### 3.2 INSTALLATION

- A. Install valves in conformance with:
  - 1. The Shop Drawings reviewed by Engineer.
  - 2. The Manufacturer's recommendations.
- B. Install Valves:
  - 1. At all branch piping connection to mains.
  - 2. At all connections to equipment.
  - 3. As required for complete control or isolation of any piece of equipment or service to branch lines.
  - 4. In accessible locations.
  - 5. Equal in flow area to connecting piping, unless otherwise indicated.
- C. No valve shall be installed with its stem below the horizontal.
- D. Furnish chain operated hand wheels, including rust-proof chain and chain guide for inaccessible overhead valves.
- E. Install flanged valves at equipment in a manner which allows equipment side of valve to be opened up without draining piping system.

END OF SECTION 22 05 23

## SECTION 22 05 29 – HANGERS AND SUPPORTS FOR PLUMBING PIPING AND 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 the furnishing and installation of all pipe hanging and support systems.

#### 1.3 REFERENCES

- A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with the following:
  - 1. ASME - American Society of Mechanical Engineers:
    - a. B31.9 - Building Services Piping.
    - b. B31.8 - Gas Transmission and Distribution Piping Systems.
  - 2. MSS - Manufacturers Standardization Society:
    - a. SP-58 - Pipe Hangers and Supports - Materials, Design and Manufacture Selection Application and Installation - 2009.
    - b. SP-69 - Pipe Hangers and Supports - Selection and Application - 1996.
    - c. SP-90 - Guidelines on Terminology for Pipe Hangers and Supports.

#### 1.4 DEFINITIONS

- A. Pipe Restraint: Pipe supporting element which is designed to limit or direct pipe movement due to internal static pressure, gravitational forces, frictional forces from hangers, rollers, and guides, and forces from expansion compensation devices:
  - 1. Pipe restraints are not designed to restrain pipe movement caused by thermal expansion, shock or surge.
- B. Pipe Guide: A pipe restraint designed to direct pipe movement along a single axis.
- C. Pipe Anchor: A pipe restraint designed to provide a static point about which pipe movement normally occurs, by limiting the longitudinal and axial movement at that point.
- D. Other Terms: As defined in MSS SP-90.

#### 1.5 DESIGN AND PERFORMANCE REQUIREMENTS

- A. Unless otherwise indicated on Drawings or in these Specifications, this Contractor shall be responsible to design and provide all pipe hangers, supports, restraints, braces, framing, etc., as required to comply with all applicable building codes, ASME B31 and MSS SP-69.
- B. Comply with the requirements of Division 21 Section "Water Based Fire Suppression Systems" for pipe hangers and supports for fire protection piping.
- C. Comply with the requirements of ASME B31.8 for pipe hangers and support of natural gas piping systems.
- D. The Work in this Section includes responsibility for all hangers, supports, restraints, braces, framing, etc. as required to comply with the seismic restraint requirements of the Michigan Rehabilitation Code For Existing Buildings of 2015.

## 1.6 SUBMITTALS

- A. Manufacturer's Literature: For structural steel attachment devices, hangers and rollers. Include name of Manufacturer; model number and MSS Type, if applicable; and piping systems to be used with.
- B. Submit Shop Drawings for all engineered hanger, restraints, and support assemblies.
- C. Upon request by Engineer, submit calculations for all engineered hanger, restraints, and support assemblies.

## 1.7 PERFORMANCE REQUIREMENTS

- A. Design Responsibilities:
  - 1. Anchorage of outdoor piping shall be designed by Contractor or their supplier.
  - 2. Minimum Requirements:
    - a. Details, if any, indicated on the Drawings and Specifications contained herein are minimum requirements.
      - 1) Engineer has designed the structure to withstand the gravity and wind induced loadings of equipment.
      - 2) Notify Engineer of member size change requirements prior to fabrication.
    - b. Generally comply with layouts and configurations as indicated on the Drawings.
  - 3. Structural Performance:
    - a. Design shall be performed by a professional engineer.
    - b. Design shall comply with the building code plus amendments and local ordinances, if any, legally adopted for the location in which the Project is located.
    - c. Design anchorage systems capable of withstanding design loads within limits and under conditions indicated.
      - 1) The term "withstand" means that the unit will remain in place without separation of any parts from the device when subjected to the wind forces specified.
    - d. Design shall include systems that transfer gravity and wind induced loadings (including lateral, overturning and uplift effects) to the structure, including, but not limited to:
      - 1) Anchorage between piping and supports.
      - 2) Anchorage between supports and building structure.
      - 3) Spacers, blocking, straps and the like.
  - 4. Design Loads:
    - a. Dead Loads: Actual weights of materials and fixed equipment, as calculated by designer.
    - b. Wind-Restraint Loading:
      - 1) Basic Wind Speed: 120 mph.
      - 2) Building Classification Category: II.
      - 3) Design shall not consider shielding by adjacent structures.

## PART 2 - PRODUCTS

### 2.1 GENERAL REQUIREMENTS

- A. The materials of all pipe hanging and supporting elements shall be in accordance with the latest requirements of the ASME Code for Pressure Piping B31.1 and MSS Standard Practice MSS SP-58 and MSS SP-69 except as supplemented or modified by the requirements of these Specifications.
- B. The material in contact with the pipe shall be compatible with the piping material so that neither shall have a deteriorating action on the other.
- C. Special Finishes and Materials:
  - 1. All ferrous hangers and supports used in the following areas shall be hot dip galvanized unless noted otherwise:
    - a. Outside.
    - b. In wet or potentially wet areas.

## 2.2 MANUFACTURERS

- A. Elcon.
- B. Michigan Hanger.
- C. Anvil.
- D. Bergen.
- E. Hilti.
- F. Lindapter.
- G. Thybar
- H. Pate
- I. Mirro
- J. Roof Products and Systems
- K. A.E.S.
- L. MicroMetl.
- M. PHD Manufacturing.

## 2.3 PIPE HANGERS AND SUPPORTS

- A. Horizontal Piping Hangers: Unless otherwise indicated and except as specified in piping system Specification sections, install the following types:
  - 1. Adjustable Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30 (DN15 to DN750).
  - 2. Yoke Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 degrees F (49 to 232 degrees C) pipes, NPS 4 to NPS 16 (DN100 to DN400), requiring up to 4 inches (100 mm) of insulation.
  - 3. Carbon or Alloy Steel, Double Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24 (DN20 to DN600), requiring clamp flexibility and up to 4 inches (100 mm) of insulation.
  - 4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24 (DN15 to DN600), if little or no insulation is required.
  - 5. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4 (DN15 to DN100), to allow off-center closure for hanger installation before pipe erection.
  - 6. Adjustable Swivel Split or Solid Ring Hangers (MSS Type 6): For suspension of noninsulated stationary pipes, NPS 3/4 to NPS 8 (DN20 to DN200).
  - 7. Adjustable Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8 (DN 15 to DN200).
  - 8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8 (DN15 to DN200).
  - 9. Adjustable Swivel Ring Band Hangers (MSS Type 10): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 2 (DN15 to DN50).
  - 10. Split Pipe Ring With or Without Turnbuckle Adjustment Hangers (MSS Type 11): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 8 (DN10 to DN200).
  - 11. Extension Hinged or 2 Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 3 (DN10 to DN80).
  - 12. U-Bolts (MSS Type 24): For support of heavy pipe, NPS 1/2 to NPS 30 (DN15 to DN750).
  - 13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.

- B. Supports and Rollers:
1. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36 (DN100 to DN900), with steel pipe base stanchion support and cast iron floor flange.
  2. Pipe Stanchion Saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 36 (DN100 to DN900), with steel pipe base stanchion support and cast iron floor flange with U-bolt to retain pipe.
  3. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion type support for pipes, NPS 2-1/2 to NPS 36 (DN65 to DN900), if vertical adjustment is required, with steel pipe base stanchion support and cast iron floor flange.
  4. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30 (DN25 to DN750), from 2 rods if longitudinal movement caused by expansion and contraction might occur.
  5. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20 (DN65 to DN500), from single rod if horizontal movement caused by expansion and contraction might occur.
  6. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42 (DN50 to DN1050), if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
  7. Pipe Roll and Plate Units (MSS Type 45): For support of pipes, NPS 2 to NPS 24 (DN50 to DN600), if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
  8. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes, NPS 2 to NPS 30 (DN50 to DN750), if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.
- C. Vertical Piping Clamps: Unless otherwise indicated and except as specified in piping system specification sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20 (DN20 to DN500).
  2. Carbon or Alloy Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20 (DN20 to DN500), if longer ends are required for riser clamps.
- D. Hanger Rod Attachments: Unless otherwise indicated and except as specified in piping system specification sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches (150 mm) for heavy loads.
  2. Steel Clevises (MSS Type 14): For 120 to 450 degree F (49 to 232 degree C) piping installations.
  3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type II, split pipe rings.
  4. Malleable Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
  5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 degree F (49 to 232 degree C) piping installations.
- E. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Specification sections, install the following types:
1. Restraint Control Devices (MSS Type 47): Where indicated to control piping movement.
  2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches (32 mm).
  3. Spring Cushion Roll Hangers (MSS Type 49): For equipping Type 42 roll hanger with springs.
  4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
  5. Variable Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25% to absorb expansion and contraction of piping system from hanger.
  6. Variable Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25% to absorb expansion and contraction of piping system from base support.
  7. Variable Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25% to absorb expansion and contraction of piping system from trapeze support.
  8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load adjustment capability. These supports include the following types:
    - a. Horizontal (MSS Type 54): Mounted horizontally.
    - b. Vertical (MSS Type 55): Mounted vertically.
    - c. Trapeze (MSS Type 56): Two vertical type supports and 1 trapeze member.



## 2.4 HANGER RODS

- A. Minimum rod diameters for rigid rod hangers shall be as shown in MSS SP-69 Table 4 (Minimum Rod Diameter for Single Rigid Rod Hangers) and as indicated in Part 3 of these Specifications.
- B. Hanger rods shall be subject to tensile loading only. At hanger locations where lateral or axial movement is anticipated, suitable linkage shall be provided to permit swing.
- C. Rod material must be compatible with hanger and comply with above. Do not field cut thread on galvanized rod.
- D. Do not use perforated strap.
- E. Multiple Supports:
  - 1. Horizontal banks of pipe may be supported on a common base member without regard to the pipe centerline elevation.
  - 2. In the supporting of multiple pipe runs, provisions shall be made to keep the lines in their relative lateral positions, using clamps or clips as required. Lines subject to thermal expansion shall be free to roll axially or slide.

## 2.5 SADDLES AND SHIELDS

- A. All Piping:
  - 1. Saddle: MSS Type 39 Anvil Figure 160 to 165.
  - 2. Shield: MSS Type 40 (Anvil Figure 167), provide and install in accordance with Manufacturer's shield size selection tables.
  - 3. The contour of the saddle shall match the radius of the pipe insulation.

## 2.6 ALIGNMENT GUIDES

- A. Provide at all expansion loops and joints:
  - 1. As indicated on the Drawings.
  - 2. As required to maintain alignment.
  - 3. In accordance with Expansion Joint Manufacturer's Association recommendations.
- B. Pipe Slides and Guides:
  - 1. Manufacturer:
    - a. Advanced Thermal Systems, Inc.
    - b. As approved by Owner.
  - 2. Model:
    - a. Figure 101-W for guide weld down applications.
    - b. Figure 101-B for guide bolt down applications.
    - c. Figure 201-W for slide weld down applications.
    - d. Figure 201-B for slide bolt down applications.
  - 3. Size: Appropriate for pipe size, insulation thickness and length of travel.
  - 4. Minimum Length of Travel:
    - a. For the first 1/4 of the distance from the anchor to the expansion joint -25% of design travel length of joint.
    - b. For the second 1/4 of the distance from the anchor to the expansion joint -50% of design travel length of joint.
    - c. For the third 1/4 of the distance from the anchor to the expansion joint -75% of design travel length of joint.
    - d. For the last 1/4 of the distance from the anchor to the expansion joint - design travel length of joint +25%.

- C. Spider Type Guides:
  - 1. Manufacturers:
    - a. Anvil.
    - b. Pentair - ERICO.
    - c. Keflex.
  - 2. Anvil, Figure 255; 256, or equal.

## 2.7 FABRICATED STEEL SUPPORTS AND RESTRAINTS

- A. Provide as required:
  - 1. Steel shapes and plates.
  - 2. Bolts.
  - 3. Welds.
- B. Materials and fabrication in accordance with:
  - 1. AISC Specification for the Design, Fabrication and Erection of Structural Steel for Buildings.
  - 2. AISC Code of Standard Practice for Steel Buildings and Bridges (except Section 4.2.1.).
- C. Design: Responsibility of Subcontractor.
- D. Paint all finished fabrications:
  - 1. As specified in Division 09 Section "Interior Painting."
  - 2. Color as directed by Owner.

## 2.8 MANUFACTURED METAL FRAMING SUPPORT SYSTEMS

- A. Acceptable Manufacturers:
  - 1. Eaton B-Line.
  - 2. Elcen.
  - 3. Super Strut, Inc.
  - 4. Unistrut Building Systems.
- B. Provide products from one Manufacturer.
- C. Channel (Standard Applications):
  - 1. Mild strip steel.
  - 2. 12-gage minimum material.
  - 3. Factory painted equal to Unistrut Perma-Green.
  - 4. Equal to Unistrut Part No. P1000.
- D. Clamps and Supports:
  - 1. Beam clamp equal to Unistrut Part No. P2785.
  - 2. Pipe strap equal to Unistrut Part No. P2558.
  - 3. Pipe roller equal to Unistrut Part No. P2474.
  - 4. All items fabricated in material equal to channel specifications.
  - 5. Copper pipes supported on metal framing support channels shall be protected from galvanic corrosion by special insulators between the pipe clamp and the channel.
- E. Clamp Nuts:
  - 1. Electro-galvanized stainless steel for use with stainless steel and fiberglass parts.
  - 2. Mild bar steel for standard applications.
  - 3. Class 2 American Standard threads.
  - 4. Equal to Unistrut Part No. P1012.

## 2.9 MANUFACTURED PIPING SUPPORT SYSTEM SUBJECT TO WIND OR SEISMIC LOADING

- A. Support Rails:
1. General Construction:
    - a. Material: ASTM A653 G90 hot dipped galvanized steel. Minimum 18 gage or heavier, as engineered by Manufacturer.
    - b. Corners: Mitered and welded (welds are micro sealed and prime painted after fabrication). Bolted connections are not accepted.
    - c. Base Plates: Integral to frame and welded.
    - d. Internally reinforced with galvanized 1-inch x 1-inch angles for curbs exceeding 3-foot length.
    - e. Wood Nailers: Factory installed, decay resistant. Size and width as suitable for support of items installed on rail and perimeter of roof deck.
  2. Height: Minimum 12 inches above finished roof surface. Select support so mechanical equipment air inlets are at least 18 inches above the finished roof surface.
  3. Constructed to match roof slope with plumb and level top surface for mounting mechanical equipment.
  4. Gasketing: Where required, 1/4-inch thick, 1-inch wide under all units.
  5. Counterflashing: 16 gage galvanized steel.
  6. Rail assembly shall be installed under metal roof deck. Perimeter steel roof deck shall be supported by rail assembly. Rail bottom flange shall be a minimum width of 2 inches to support roof deck. Steel clips shall be provided where roof deck flutes do not contact bottom flange of rail, to prevent crushing roof deck.
  7. Non-canted style.
- B. Support Frames
1. General Construction:
    - a. Material: Polycarbonate, hot-dipped galvanized steel or stainless steel, as engineered by Manufacturer.
    - b. Frame supports are adjustable, utilizing all thread.
    - c. Frame bases constructed of non-metallic material compatible with roofing material requirements.
    - d. Platforms: Constructed of 18 gage material.
- C. Wind and Seismic Restraints: Metal brackets compatible with the equipment support and equipment casing, galvanized or painted to match equipment unit, used to anchor unit to the support, and designed for loads at Project site.
- D. Building Structural Steel Attachment: Provide wind restraint straps, welded strap connectors, and bolted or welded attachment methods to roof structural steel as required to meet wind uplift requirements.

## 2.10 BUILDING ATTACHMENTS

- A. As indicated on the Drawings or in the Specifications.
- B. Concrete Attachments:
1. Provide galvanized finish for all attachments used in wet or potentially wet areas.
  2. Provide stainless steel bolts and nuts in wet and potentially wet areas.
  3. Poured Concrete:
    - a. Use cast-in-place inserts or bolted surface mounted attachments, at Contractor's option.
    - b. Expansion style anchors are not permitted on piping systems subject to vibration.
  4. Precast Concrete Tees:
    - a. Use fittings specifically designed for attachment to stems of precast tees.
    - b. Drilling is not permitted except where specifically approved by Engineer and coordinated with precast Manufacturer to miss embedded, prestressed steel strands.
  5. Precast Concrete Plank:
    - a. Use toggle bolt attachment as indicated on Drawings.
    - b. Alternatively, provide adhesive anchor, Hilti HY-20; or as approved.
    - c. Drilling is not permitted except where specifically approved by Engineer and coordinated with precast Manufacturer to miss embedded, prestressed steel strands.

- C. Horizontal Piping:
  - 1. Steel W, I, or S shapes: MSS Type 23 clamp with retaining clip, (Anvil Fig. 88, Fig. 89 for non-seismic and Fig. 89X for seismic applications) up to 2-inch; MSS Type 28 (Anvil Fig. 292) or MSS Type 21 (Anvil Fig. 133, 134) above 2-inch.
  - 2. Steel Channel: MSS Type 20 universal channel clamp.
  - 3. Bar Joists: Steel washer plate (Anvil Fig. 60).
  - 4. Concrete: See "B" above.
- D. Vertical Piping:
  - 1. Steel Shapes: Welded brackets as approved by Engineer.
  - 2. Concrete: See "B" above.
- E. In the absence of a Specification for a particular type of attachment, furnish attachments comparable in type and quality to that specified above for a similar situation.

### PART 3 - EXECUTION

#### 3.1 HANGER AND SUPPORT APPLICATIONS

- A. General Requirements:
  - 1. The selection of pipe hangers and supports shall be based on the overall design concept of the piping system and any special requirements which may be called for in these Specifications or as indicated on the Drawings. The support systems shall provide for, and control, the free or intended movement of the piping including its movement in relation to that of the connected equipment. They shall prevent excess stress resulting from the transfer of weight being introduced into the pipe or connected equipment.
  - 2. The selection of hangers and supports shall be made to provide the piping system with the degree of control that its operating characteristics require.
  - 3. The selection of hangers or supports will take into consideration the combined weight of the supported systems, including system contents and test water.
  - 4. Select and install hangers and supports to allow controlled thermal and seismic movement of piping system, to permit freedom of movement between pipe anchors, and facilitate action of expansion joints, expansion loops, expansion bends and similar units.
  - 5. The spans in MSS SP-69 Table 3 do not apply where concentrated weights, such as valves or heavy fittings, or where changes in direction of the piping occur between hangers.
  - 6. Select all hangers and supports rated for the maximum potential loading with pipe full.
  - 7. Select hangers for cold (less than 50 degrees F) piping service for installation over the insulation.
  - 8. Where significant, vertical movement of pipe occurs at the hanger location a resilient support must be used:
    - a. Selection of resilient supports shall be based on permissible load variations and effects on adjacent equipment. Support selection for typical load variations are shown on MSS SP-69 Table 2 (Spring Support Selection). Load and movement calculations shall be made for the proper selection of spring hangers.
    - b. Vertical movement and load transfer from riser expansion to horizontal runs shall be given consideration when applying spring hangers.
    - c. Spring cushion hangers may be used where vertical movement does not exceed 1/4-inch and where formal load and movement calculations are not required.
    - d. Variable spring hangers shall be used for all other resilient support requirements except as noted in the following paragraph.
    - e. Constant support hangers shall be used on piping systems where the deviation in supporting force must be limited to 6% and which cannot be accommodated by a variable spring hanger.
- B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Specification sections.

#### 3.2 HANGER AND SUPPORT INSTALLATION

- A. Pipe Hanger and Support Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

- B. General:
  - 1. Adjust all components as required for proper operation and required pipe slope.
  - 2. Double nut all support rods at hangers.
  - 3. Location and Routing:
    - a. Install Piping as Indicated:
      - 1) On the Drawings.
      - 2) On the reviewed Shop Drawings.
    - b. Secure Engineer's approval for all pipe routing changes.
  - 4. Coordinate with other trades for placement of concrete attachments prior to concrete pouring.
  - 5. Install all items in accordance with Manufacturer's instructions.
- C. Support at Valves: Provide additional supports at all valves in piping 4-inch and larger.
- D. Vertical Risers:
  - 1. Support independently from adjacent hangers on horizontal piping.
  - 2. Cast Iron Waste, Vent or Drainage Piping:
    - a. Support at the base and at each floor level.
    - b. Support spacing not to exceed 15-foot centers.
  - 3. Copper Piping:
    - a. Support at the base and at 6-foot maximum centers for sizes 1-1/4-inch and smaller.
    - b. Pipes Larger Than 1-1/4-Inch:
      - 1) Supported at each floor level.
      - 2) Not to exceed 10-foot centers.
  - 4. Vertical Threaded, Welded or Grooved Steel Piping:
    - a. Support at the base of the riser and at every other floor.
    - b. Maximum allowable unsupported piping length is 12 feet.
- E. Horizontal Runs:
  - 1. General:
    - a. Provide adequate supports for the loads with a factor of safety of at least 5 (400 pounds minimum).
    - b. Provide protective shield at all hangers and rollers supporting plastic pipe and coated pipe.
    - c. Support spacing not to exceed MSS SP-69 Table 3, or the requirements for seismic restraint, whichever is more stringent.
    - d. Hanger rod diameter shall not be less than the requirements of MSS SP-69 Table 4, or the requirements for seismic restraint, whichever is more stringent.
  - 2. Rollers: All piping systems designed to accommodate thermal expansion movement shall be mounted on rollers.
  - 3. Bar Joists: Attachments to bar joists shall be made to top member and at panel points.
- F. Ductile Iron Piping: The size of hanger components shall be suitable for the O.D. of the pipe to be supported.
- G. Cast Iron Soil Piping:
  - 1. The size of hanger components shall be suitable for the O.D. of the pipe to be supported.
  - 2. Spacing shall comply with MSS SP-69 Table 3.

### 3.3 PIPE RESTRAINTS

- A. Provide adequate pipe restraints for all expansion or contraction of piping due to temperature change:
  - 1. Including, but not limited to, that indicated on the Drawings.
  - 2. As instructed by Owner or Engineer.
  - 3. At locations to prevent stresses from exceeding those permitted by ASME B31 and to prevent transfer of loading and stresses to connected equipment.
  - 4. Spacing: Unless otherwise indicated, install at ends of main pipe runs, at intermediate joints in pipe runs between expansion loops and bends.
- B. Concrete work installed in connection with anchors or supports: Make with approved Portland Cement:
  - 1. At least 5-1/2 bags per cubic yard.
  - 2. Properly mixed with approved aggregate.
  - 3. Attain a compression strength of not less than 3,000 psi at 28 days.

### 3.4 INSULATION PROTECTION

- A. Provide Protection Saddle:
  - 1. Equal to insulation thickness.
  - 2. At each hanger.
  - 3. For all insulated piping systems where longitudinal expansion exceeds 1-inch per 100 feet.
- B. Provide preservative treated wood block "saddle" for all insulated domestic cold water piping systems larger than 3-inch IPS. Anvil Fig. 160 to 165 is also acceptable.

- C. Provide insulation protection shield:
  - 1. At each hanger for all "cold" (less than 50 degrees F) piping services.
  - 2. In accordance with the following table:

Pipe Size (IPS)	Shield Gage	Length
5 inches and Smaller	16	12 inches
6 inches to 12 inches	12	16 inches
Greater than 12 inches	12	20 inches

- 3. Installed as follows:
  - a. Surround lower covering.
  - b. Straddle equidistant on hanger.
  - c. Flared at both ends as required to avoid damage to pipe covering, jacket and vapor barrier.

### 3.5 PAINTING

- A. Touchup: Cleaning and touchup of painting of field welds, bolted connections and abraded areas of shop paint on miscellaneous metal are specified in Division 09 Section "Interior Painting."
- B. Galvanized Surfaces: Clean welds, bolted connections and abraded areas. Apply galvanizing repair paint to comply with ASTM A780.

END OF SECTION 22 05 29

## SECTION 22 05 31 – PENETRATIONS FOR PLUMBING

### 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 furnishing and installation of the major items listed below:
  - 1. Pipe sleeves.
  - 2. Prefabricated and site built curb assemblies.
  - 3. Flashing and sealing of all mechanical openings through weather or waterproofed walls, roofs, and floors.
  - 4. Sealing and finishing of all mechanical openings.
  - 5. Provide UL rated firestopping and sealing at all new and existing pipe penetrations of fire rated walls.
- B. Division of Work: In accordance with the General Conditions, Contractor is responsible for dividing the Work among the Subcontractors and Suppliers and for delineating the work to be performed by specific trades. The following are suggestions as to how the Work may be divided. This is not a complete list of all the work:
  - 1. General Contractor:
    - a. Locate and place all sleeved and framed openings as part of constructing the wall and floor surfaces in which the openings occur.
    - b. Provide all lintels and required stiffening members for wall and floor openings.
    - c. Cut roofing and install flashing for all required openings in proprietary roof membrane systems.
    - d. Cut all roof deck openings and provide required framing supports.
  - 2. Mechanical Subcontractor:
    - a. Advise General Contractor of quantity, location and size of all required openings.
    - b. Provide all curbs, sleeves, seals, escutcheons and related materials required for finishing, sealing and waterproofing mechanical openings. Furnish all flashing and counterflashing.
    - c. Arrange and pay for all openings required after wall, roof and floor construction is complete.

#### 1.3 REFERENCES

- A. Except as herein specified or as indicated on the Drawings, the Work of this Section shall comply with ASTM D2202 - Test Method for Slump of Sealants.

#### 1.4 SUBMITTALS

- A. Manufacturer's Literature: For all premanufactured curbs and sealing assemblies.
  - 1. Manufacturer's name.
  - 2. Model number.
  - 3. Details of construction and installation.
  - 4. Certified load-bearing data for all curbs.

#### 1.5 QUALITY ASSURANCE

- A. Fabrication and Installation Personnel Qualifications:
  - 1. Trained and experienced in the fabrication and installation of the materials and equipment.
  - 2. Knowledgeable of the design and the reviewed submittals.
- B. Codes and Standards: "Architectural Sheet Metal Manual" as published by SMACNA.
- C. Openings in Fire-Rated Surfaces: As specified in Division 07 Section "Firestopping."

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Prefabricated Stack Sleeve Assemblies:
  - 1. Josam.
  - 2. Wade.
  - 3. Zurn.
- B. Pipe Seals and Boots:
  - 1. The Pate Company.
  - 2. Portals Plus, Inc.
  - 3. Roof Products and Systems Corporation.
  - 4. Thunderline Corporation.
  - 5. Thycurb Corporation.
- C. Modular Mechanical Seals:
  - 1. Thunderline/Link-Seal.
  - 2. As approved.
- D. Backer Rod: Industrial Thermo Polymers, "Standard Backer Rod".
- E. Acoustical Sealant: Pecora, "BA-98".
- F. Non-Expanding Sealant: General Electric SilPruf SCS2000:
  - 1. VOC content must be 250 g/liter or less.

### 2.2 MATERIALS

- A. Backer Rod:
  - 1. Extruded round, closed cell, polyethylene foam.
  - 2. Resilient, non-exuding.
  - 3. Density: 2.0 pounds per cubic foot.
  - 4. Tensile Strength: 50 psi.
  - 5. Nonabsorbent to water and gasoline.
  - 6. Suitable for use as a backing for acoustical sealant.
  - 7. Compatible with sealant and approved by sealant Manufacturer.
- B. Acoustical Sealant:
  - 1. Nonfire-Rated Penetrations:
    - a. Non-drying, non-hardening and non-bleeding.
    - b. Laboratory tested sealant which effectively reduces airborne sound transmission through wall systems.
    - c. Viscosity: 350,000 to 400,000 (Brookfield No. 65, 10 RPM).
    - d. Aging: Firm but rubbery, good tack after 50 days conditioned at 160 degrees F.
    - e. Slump: 0.1 to 0.2 inches in accordance with ASTM D2202.
    - f. Color: Gray.
  - 2. Fire-Rated Penetrations: Permanently flexible, approved firestop putty. Refer to Division 07 Section "Firestopping."
- C. Packing Material for Penetrations:
  - 1. Glass Fiber or Mineral Fiber:
    - a. Noncombustible.
    - b. Resistant to water, mildew, and vermin.
  - 2. Expanding Resilient Foams:
    - a. Acceptable alternative if manufactured for this purpose.
    - b. Minimum material density: 60 pounds per cubic foot.



## 2.3 SLEEVES

- A. Materials:
  - 1. 18-Gage Galvanized Steel: For pipe penetrations in non-bearing walls.
  - 2. Schedule 40 Steel Pipe:
    - a. For all bearing walls.
    - b. For all floors.
  - 3. Cast Iron Pipe: For all exterior below grade installations.
- B. Size All Sleeves:
  - 1. To allow for movement due to expansion.
  - 2. To provide for continuous insulation, except as required by Division 07 Section "Firestopping."
  - 3. As indicated on the Drawings.

## 2.4 MANUFACTURED UNITS

- A. Stack Sleeves and Flashing Fittings:
  - 1. Provide as required for roof and floor pipe penetrations.
  - 2. Equal to Josam 264xx series products.
- B. Exterior Pipe Opening Seals:
  - 1. Compatible with installation conditions.
  - 2. Equal to One of the Following:
    - a. Pate "Pipe Seal".
    - b. Portals Plus Model C-126.
  - 3. Link-Seal.
- C. Modular Mechanical Seals:
  - 1. Provide modular, mechanical type, consisting of inter-locking synthetic rubber links shaped to continuously fill the annular space between the pipe and the wall opening.
  - 2. The elastomeric element shall be sized and selected in accordance with Manufacturer's recommendations and have the following properties as designated by ASTM:
    - a. For Standard Service Applications:
      - 1) -40 to +250 degrees F (-40 to +121 degrees C).
      - 2) EPDM = ASTM D2000 M3 BA510.
    - b. For High Temperature or Fire Seal Applications:
      - 1) -67 to +400 degrees F (-55 to +204 degrees C).
      - 2) Silicone = ASTM D2000 M1GE505.

## PART 3 - EXECUTION

### 3.1 ROOF OPENINGS

- A. Piping:
  - 1. As indicated on the Drawings.
  - 2. For Multiple Pipes Through Single Opening:
    - a. Select sleeve of ample size to accommodate pipes.
    - b. Prefabricated insulated curbs acceptable.
  - 3. Fill Annulus Opening:
    - a. Use non-combustible insulation material.
    - b. Full depth of sleeve.
  - 4. Provide Moisture Protection Using:
    - a. Elastomeric boot.
    - b. Metal hood.
    - c. Flashing fitting.
- B. Locate curbs and sleeves a minimum of 12 inches from walls to permit proper flashing.

### 3.2 INTERIOR WALL AND FLOOR OPENINGS

- A. Flash all floor-mounted drains except in slabs on grade:
  - 1. Use integral flashing flange and clamp.
  - 2. As specified in Division 22 Section "Plumbing Pumps."
- B. Use riser sleeve with integral flashing flange and clamp for all waterproof membrane floors.
- C. Seal airtight all openings around pipes in the structure at:
  - 1. Mechanical equipment rooms.
  - 2. Slab and noise sensitive wall penetrations including penetrations in walls separating plant area from office areas.
  - 3. Penetrations of all drywall ceilings and concrete slabs suspended on isolators.
  - 4. All enclosed shaft penetrations.
- D. Pipe Penetrations:
  - 1. Domestic Water, Sewer, Drain and Vent Piping:
    - a. Where a pipe passes through a wall, ceiling, or floor slab, cast or grout a steel sleeve into the structure.
    - b. Internal diameter of the sleeve: 2 inches (50 mm) larger than the external diameter of the pipe passing through it.
    - c. After all of the piping is installed in a specific area, check the clearance and correct it, if necessary, to within 1/2-inch (12 mm).
    - d. Pack the void full depth with packing material and seal at both ends, 1-inch (25 mm) deep.
    - e. In noise-critical walls and floors, pack with sealant backed by foam rod.
    - f. Where pipes pass through a masonry wall in sufficient numbers and density that individual pack-and-calk details are not possible, a special isolation detail shall be developed:
      - 1) Cast pipe sleeves in a block of concrete with the sleeves located a minimum of 2 inches (50 mm) apart.
      - 2) Block thickness: At least as thick as the surrounding wall construction.
      - 3) Each sleeve diameter: 2 inches (50 mm) larger than the external diameter of the pipe passing through it.
      - 4) Build the sleeved block into the wall.
      - 5) After the pipes are installed, pack and calk voids as indicated above.

### 3.3 OUTSIDE WALL OPENINGS

- A. Pipes:
  - 1. Pass through sleeves fabricated of Schedule 40 pipe cut 3/8-inch back from face of wall on each side.
  - 2. Sealed 100% watertight.
  - 3. Pipes below grade use cast iron sleeves.

### 3.4 FLOOR SLEEVES IN POTENTIALLY WET AREAS

- A. All floors except slabs on grade.
- B. Extend sleeves 3 inches above finished floor.
- C. Provide poured concrete curb for duct openings as indicated in the Drawings.

### 3.5 ESCUTCHEONS AND CLOSURE COLLARS

- A. Includes ceilings, partitions, floor and walls.

- B. Provide Escutcheons for All Piping:
1. Sized to fit over coverings.
  2. In All Potentially Wet Areas: Stainless steel.
  3. In All Dry Finished Areas: Chrome plated.
  4. Do not use escutcheons in acoustic isolation walls unless otherwise indicated.

END OF SECTION 22 05 31

## SECTION 22 05 73 – TESTING AND CLEANING OF PLUMBING 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. This Section includes providing testing and cleaning services and the major items listed below:
  - 1. Provide all pumps, gages, valves and other equipment and material necessary to properly conduct tests and perform cleaning.
  - 2. Arrange and pay for all costs of utilities and chemicals required for the Work.
  - 3. Repair and Restore All Work Damaged:
    - a. By tests.
    - b. By cutting required in connection with the tests.

#### 1.3 SUBMITTALS

- A. Flushing and Cleaning:
  - 1. Submit certificates for all code-required inspections.
  - 2. Submit all water Sample analysis reports as required in Part 3 of these Specifications.
- B. Pressure Test Reports:
  - 1. Submit within 1 week after each system pressure test.
  - 2. List time, date and persons present for the following for each system:
    - a. Initial tests.
    - b. Final test.
  - 3. Include report indicating:
    - a. Test type and duration.
    - b. Initial pressure.
    - c. Final pressure.
  - 4. Indicate that necessary repairs and final tests were satisfactorily completed.

#### 1.4 QUALITY ASSURANCE

- A. Comply with all applicable codes.
- B. Secure State Health Department approval for potable water systems.
- C. Testing and Cleaning Agency:
  - 1. Minimum 15 years' experience in providing cleaning chemicals for water systems use.
  - 2. Provide regional laboratory support services.

### PART 2 - PRODUCTS

#### 2.1 CLEANING AGENT MANUFACTURERS

- A. Aqua-Chem.
- B. Aquatrol.
- C. Enerco.
- D. Nalco.

## 2.2 MATERIALS

- A. Detergents, solvents and other cleaning agents shall be compatible with materials of fabrication of systems where they are used. No cleaning agent shall adversely affect materials or mechanisms in systems and cleaning agents shall be acceptable to equipment manufacturers and the plant environmental coordinator.
- B. Detergents, solvents and other cleaning agents shall be compatible with process streams to be handled by systems in which the cleaning agents are used.
- C. Owner will provide water for pipe cleaning and flushing. Other cleaning fluids, agents, and equipment shall be provided by Contractor.
- D. Provide the necessary temporary equipment required for cleaning and flushing operations.
- E. Provide permanent hose connections for supply, discharge and recirculating lines for the new piping system.
- F. Provide piping at the ends of the main and branch lines of the piping system as required to accomplish flush of the piping.
- G. Provide a temporary pump of sufficient head and GPM required to achieve a flushing velocity of at least 10 feet per second.
- H. Provide temporary chemical skids with tote tanks as required for mixing chemicals and serving as a source reservoir and/or collection point for cleaning and flushing solutions.
- I. Provide temporary bag filters (with filter bags) as required for removal of contaminants from flushing process.
- J. Provide all hose, electrical leads and supply connections for completion of system required to fill, drain and refill of the lines utilizing plant supplied water and power.

## PART 3 - EXECUTION

### 3.1 PIPING SYSTEM PRESSURE TEST

- A. General:
  - 1. Perform all tests before piping is painted, covered, concealed or backfilled.
  - 2. Before testing, remove or otherwise protect from damage, control devices, air vents, fixtures, meters, or other parts which are not designated to withstand test pressures.
- B. Test Procedures:
  - 1. Air Test:
    - a. Charge with air to the test pressure specified.
    - b. When possible, perform test when ambient air temperature is constant.
  - 2. Soap Test:
    - a. Charge with air, water or carbon dioxide to pressure specified.
    - b. Examine all joints for leaks with a soap suds solution.
  - 3. Water Test:
    - a. Charge with water to the pressure specified.
    - b. Exterior Surface of Pipe and Fittings:
      - 1) Show no cracks or other form of leaks.
      - 2) Completely drip dry.

C. Pressure Test Criteria:

1. Test criteria below are minimum requirements. In addition, the requirements of State and Local Codes having jurisdiction shall be met:

Piping System	Type Test	Pressure	Allowable Pressure Drop	Minimum Test Duration
Drainage System	Water	5 psig	0 psi	30 Minutes
Vent System	Water	5 psig	0 psi	30 Minutes
Water (Domestic)	Water	100 psig	0 psi	4 Hours
Gas *	*	*	*	*
*See below for natural gas piping pressure tests				

2. Natural Gas Piping:

- a. Test in accordance with NFPA 54, Sections 8.1.4.2 and 8.1.4.3.
- b. Test pressure to be used shall be no less than 1-1/2 times the proposed maximum working pressure, but not less than 3 psi.
- c. Where the test pressure exceeds 125 psi (862 kPa), the test pressure shall not exceed a value that produces a hoop stress in the piping greater than 50 percent of the specified minimum yield strength of the pipe.
- d. Test duration shall be not less than 1/2 hour for each 500 cubic feet (14 cubic meter) of pipe volume or fraction thereof. When testing a system having a volume less than 10 cubic feet, the test duration shall be a minimum of 10 minutes. The duration of the test shall not be required to exceed 24 hours.

### 3.2 FLUSHING AND CLEANING PROCEDURES

A. Preinstallation Cleaning:

1. Before installation, unless otherwise specified, piping shall be cleaned as follows:
  - a. Hammer, brush, scrub with soapy rags, to loosen sand, dirt, or scale when necessary. Remove excess grease and oil from exterior surface.
  - b. Blow with air, or flush with clean water, and inspect before erection.
  - c. Pipe cleaned and stored before installation shall be dried and ends sealed with a rigid plug or flange protector and tape.
  - d. Physical cleaning procedures shall not damage materials or mar surfaces of such materials. Hammering shall not be used on cast iron, fiberglass-reinforced plastic, or plastic pipe.

B. Prior to Flushing:

1. Remove orifice plates, traps, strainer elements, flow control valves, prior to or during process of cleaning. Remove instruments which might be damaged by cleaning procedures. Replace such items with spool pieces, plugs, or blind flanges. A "blind list" shall be prepared listing where blinds have been installed for cleaning and shall be provided to Owner after cleaning is complete to verify that all blinds have been removed.
2. Items removed from piping system shall be cleaned separately.
3. Lock valves in open position.
4. Use new gaskets, thread lubricants when removed items are reinstalled after cleaning.
5. Temporary Strainers: Disconnect piping to be flushed from equipment or install temporary strainers immediately upstream of such equipment.

C. System Protection:

1. Protect piping and equipment against overpressure, collapse from vacuum, and hydraulic shock during flushing and draining procedures.
2. Exercise special care with polyvinyl chloride (PVC) and fiberglass-reinforced plastic (FRP) piping and upon initial filling of long pipe runs to determine that pipe is in contact with hangers and supports before filling. Piping bowed out of hangers or supports will settle or lengthen during filling and resulting forces may be damaging at changes in direction.
3. Install high point vents and low point drains required to remove trapped air and to drain flushing liquid.

D. Domestic, Fire Protection and Other Open Water Piping Systems: Flush with clean water until all foreign matter is removed.

- E. Remove and clean all strainers after flushing is complete.
- F. Drain completely and refill after flushing.
- G. Natural Gas Piping Systems:
  - 1. Blow clear using oil-free compressed air.
  - 2. Prior to pressure testing and final equipment connection.

### 3.3 POTABLE WATER PIPING DISINFECTION

- A. Disinfect new or repaired potable water systems in accordance with the method prescribed by the local health authority or, in the absence of a prescribed method, in accordance with either AWWA C651 or AWWA C652 or in accordance with the current edition of the International Plumbing Code as described below. This requirement shall apply to "on Site" or "in-plant" fabrication of a system or to a modular portion of a system.
- B. Flush the piping system with clean, potable water until dirty water does not appear at any of the points of outlet. Coordinate disposal of all flushing and disinfecting water with the plant environmental coordinator. Install temporary hoses as required to reach existing disposal points, or collect the water in a portable tote tank for transfer to the proper disposal location.
- C. Fill the piping with a water/chlorine solution containing at least 50 parts per million (50mg/L) of chlorine, and the piping shall be valved off and allowed to stand for 24 hours; or the piping shall be filled with a water/chlorine solution containing at least 200 parts per million (50mg/L) of chlorine, and allowed to stand for 3 hours; after which the chlorine level shall be tested.
- D. Following the required standing time and testing, flush the piping with clean potable water until the chlorine is purged from all parts of the system piping.
- E. A bacteria test by an independent agency shall be performed, after the chlorine test has passed. Based on the result from the bacteria test, potable water shall be opened for service. The procedure shall be repeated where shown by a bacteriological examination that contamination remains present in the system.
- F. Submit water Sample to State Health Department for test and approval.

END OF SECTION 22 05 73

## SECTION 22 07 19 – PLUMBING PIPING INSULATION

### 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 furnishing and installation of piping insulation.

#### 1.3 REFERENCES:

- A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with the following:
  - 1. ASTM Specifications:
    - a. B209 - Aluminum and Aluminum Alloy Sheet and Plate.
    - b. C534 - Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
    - c. C547 - Mineral Fiber Preformed Pipe Insulation.
    - d. C552 - Cellular Glass Block and Pipe Thermal Insulation.
  - 2. ASTM Standard Test Methods: E84 - Surface Burning Characteristics of Building Materials.
  - 3. National Fire Protection Association (NFPA) publications: NFPA 255 - Surface Burning Characteristics of Building Materials: 25, 50, 50 flame spread, fuel, smoke.
  - 4. ASHRAE:
    - a. 90A - Energy Conservation in New Building Design, current edition.
    - b. 90.1 - 2019 Energy Efficient Design of New Buildings Except Low-rise Residential Buildings, with state amendments.

#### 1.4 SUBMITTALS

- A. Manufacturer's Literature: For piping insulation.
  - 1. For Each Type Used:
    - a. Name of Manufacturer.
    - b. Details of construction and installation.
    - c. Manufacturer's data (density, K-factor).
  - 2. For Each Application:
    - a. Thickness.
    - b. Total "R" value.
    - c. Jacket material.

#### 1.5 QUALITY ASSURANCE

- A. Fabrication and Installation Personnel Qualifications:
  - 1. Trained and experienced in the fabrication and installation of the materials and equipment.
  - 2. Knowledgeable of the design and the reviewed Shop Drawings.

#### 1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials in original, unbroken, brand marked containers or wrapping as applicable. Handle and store materials in a manner which will prevent deterioration and contamination with foreign matter.
- B. Reject damaged, deteriorated, or contaminated material and immediately remove from the Site. Replace removed materials at no additional cost to Owner.



## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Insulation:
  - 1. Pittsburgh-Corning.
  - 2. Owens-Corning.
  - 3. Certainteed.
  - 4. Armacell.
  - 5. Rubatex.
  - 6. Knauf.
  - 7. Johns Manville.
  
- B. Jacketing:
  - 1. Ceel-Co.
  - 2. O'Brien.
  - 3. Zeston.
  - 4. Childers.
  - 5. Pabco.
  
- C. Adhesives:
  - 1. Benjamin Foster.
  - 2. Childers.
  - 3. Vimasco.
  - 4. B.E.H.
  - 5. Or equal.

### 2.2 TYPES OF INSULATION MATERIALS

- A. Rigid Molded Glass Fiber – High Density (HFG):
  - 1. All-service jacket (ASJ) type factory applied jacketing.
  - 2. 6 lbs/cu ft minimum density.
  - 3. k factor: See scheduled value listed in table herein.
  - 4. 850 degree F service temperature.
  - 5. Owens-Corning Type SSLII; or equal.
  - 6. Typical for application on pipes below 16 inches.
  
- B. Flexible Elastomeric Thermal Pipe Insulation (E):
  - 1. Density of 5.0 lbs/cubic foot.
  - 2. k factor: See scheduled value listed in table herein.
  - 3. Maximum water vapor transmission of 0.17 per inch.
  - 4. Must be listed for 25/50 flame/smoke spread for thickness used.
  - 5. Armacell Armaflex AP; or equal.

### 2.3 PIPE AND FITTING COVERS

- A. Polyvinyl Chloride (PVC) Covers:
  - 1. Ultraviolet resistant.
  - 2. 0.030-inch minimum thickness.
  - 3. Preformed to match outer diameter of insulation.
  - 4. Preformed fitting covers, minimum 10 mil.
  - 5. Ceel-Tite 330; or equal, by Topline or Zeston.
  
- B. Aluminum Covers (A):
  - 1. ASTM B209, Alloy 3003 minimum.
  - 2. 0.016-inch thickness.
  - 3. Bright anodized or acrylic-coated smooth finish on exposed side.
  - 4. 2-piece tee and ribless elbow covers in minimum 0.016-inch, preformed.
  - 5. Provide moisture barrier backing and butt-joint with mastic seal for joining of adjacent sections.
  - 6. Childers Products Company; or as approved.

## 2.4 ACCESSORIES

- A. Adhesives: As recommended by Manufacturer.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

#### A. General:

1. Install piping insulation:
  - a. In conformance with the Drawings, these Specifications, and the Manufacturer's recommendations.
  - b. After piping system has been satisfactorily tested.
  - c. Over clean, dry piping system.
  - d. To the following thickness:
    - 1) As specified herein or as indicated on the Drawings.
    - 2) If not specified herein or indicated on the Drawings, in accordance with Manufacturer's recommendations for the specific application.
  - e. Continuous through walls, ceilings and sleeves except at fire stops.
2. Fill all cracks and voids with insulating cement carefully troweled to leave a smooth finish.
3. Repair or replace insulation damaged by:
  - a. Demolition.
  - b. Making connections to piping or equipment.
  - c. Water or mildew.
4. Insulate bundles of pipes out-of-doors with complete wrap of insulation 1-1/2 inches thick and of suitable diameter to contain bundle, with outer wrap.
5. Pipe Sizes 12-inch and Larger: Hold each 3-foot section of insulation in place with at least 3 separate loops of No. 14 AWG stranded annealed wire.

#### B. Joints and Fittings:

1. Block insulate valves and flanges with reusable insulation system.
2. Insulate elbows, tube turns, sweeps and bends with mitered sections or premolded fittings. Match pipe covering material where used.
3. Fit joints tightly together.
4. Seal joints with sealing compound and preformed aluminum bands.

### 3.2 JACKETS AND FINISH

#### A. General:

1. Provide moisture barrier between the insulation and the jacketing in a continuous, unbroken seal.
2. Hold jacketing in place by a continuous sealed joint, providing a positive weatherproof seal along the entire length of the jacket.
3. Cap off ends with caps.
4. On cold lines, cut caps to the exact size of the pipe and seal with a recommended silicone caulking.
5. Provide slip joints a minimum of every 25 feet or as needed for expansion.
6. Locate longitudinal jacket seams on indoor exposed piping out of view.

#### B. PVC:

1. Center a preformed strap (snap-strap) containing a permanently weatherproof plastic sealant over each circumferential joint and secure by tightening on a clip, or by use of a separate stainless steel banding.
2. Design snap-strap to take care of normal expansion.
3. Cover all pipe insulation and preformed insulation fittings.
4. Weld longitudinal seams together with welding adhesive as supplied by cover Manufacturer.
5. Overlap adjacent jacketing 3/4-inch and weld circumferential seams together with welding adhesive.
6. Overlap fitting covers to adjacent pipe insulation jacketing. Weld longitudinal and circumferential seams together with adhesive.

- C. Attachment:
  1. For systems operating at 50 degrees F and above: May be stapled using outward clinch staples spaced 3 inches apart at least 1/4-inch from the lap edge.
  2. For systems operating below 50 degrees F: Vapor seal laps using self-sealing lap, lap seal tape gun or adhesive such as Benjamin Foster 85-60.
- D. Taper and seal insulation ends regardless of service.
- E. Fitting and pipe jackets to have matching finishes ready for painting.
- F. For Insulation Without Factory Applied Jacket:
  1. Finish with 8-ounce glass mesh and mastic.
  2. Use breather mastic on piping operating at temperatures greater than 50 degrees F.

### 3.3 PIPING INSULATION APPLICATION SCHEDULE

- A. Basis of Thickness Chart:
  1. Thicknesses shown are based on products having a maximum "k" factor at the mean temperature listed in table herein.
  2. These Thicknesses:
    - a. Can be reduced for products having significantly lower "k" values.
    - b. Shall be increased for products having higher "k" values in order to produce equivalent or greater thermal resistance.
    - c. Changes in thicknesses shall be in accordance with ASHRAE 90.1.
- B. Flame/Smoke Ratings: Local requirements for flame and smoke ratings must be met and may exclude some options listed herein.
- C. Jackets and Finish Application:
  1. Provide PVC jacket on insulated exposed piping within 7 feet of the floor.
  2. Provide aluminum jacket on insulated piping located outside.
- D. Thickness Chart (In Inches):
  1. Key: Insulation Type (Refer to Paragraph 2.2 of this Section):
    - a. HFG = High Density Rigid Fiberglass (Pipe sizes below 16-inch).
    - b. E = Flexible Elastomeric.

PIPE SIZE										
	Piping Systems Type	Temp (F) Range	Thermal Conductivity k (BTU·in / hr·ft·F degrees)	Mean Rating Temp (F)	Less Than 1"	1" to <1-1/2"	1-1/2" to < 4"	4" to < 8"	8" & Up	Type of Insulation *
1.	Domestic Hot Water	105-140	0.22 – 0.28	100	1.0	1.0	1.5	1.5	1.5	HFG, E
2.	Miscellaneous	80-119			0.5	0.5	1.0	1.0	1.0	HFG, E
3.	Domestic Cold Water/Non-Potable Cold Water	--	--	--	0.5	0.5	1.0	1.0	1.0	HFG, E
4.	Cooling Coil Drain	--	--	--	0.5	0.5	0.5	1.0	--	HFG, E

\* See PART 2 – PRODUCTS Article 2.2 TYPES for types of insulation.

END OF SECTION 22 07 19

## SECTION 22 10 00 – PLUMBING PIPING 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 Section.

#### 1.2 SUMMARY

- A. This Section includes the furnishing and installation of all materials, labor, equipment, supervision, fees, and services incidental to proper completion of all plumbing system work:
  - 1. Domestic cold water system.
  - 2. Domestic hot water system.
  - 3. Interior waste and vent piping to 5'-0" outside building.
  - 4. Domestic Water Supply: Connect to existing water service inside building as indicated on Drawings.

#### 1.3 REFERENCES

- A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with the following:
  - 1. ANSI/ASME Standards:
    - a. A112.19.2 - V.T. China Plumbing Fixtures.
    - b. A112.1.2 - Air Gaps in Plumbing Systems.
    - c. A112.21.1 - Floor Drains.
    - d. A112.21.2 - Roof Drains.
    - e. A112.36.2M - Cleanouts.
    - f. A112.26.1 - Water Hammer Arresters.
  - 2. ASSE (American Society of Sanitary Engineering) Standards:
    - a. 1001 - Pipe Applied Atmospheric Type Vacuum Breakers.
    - b. 1003 - Water Pressure Reducing Valves.
    - c. 1011 - Hose Connection Vacuum Breakers.
    - d. 1012 - Backflow Preventers with Intermediate Atmospheric Vent.
    - e. 1013 - Reduced Pressure Principal Backflow Preventer.
    - f. 1016 - Individual Thermostatic Pressure Balancing, and Combination Pressure Balancing and Thermostatic Control Valves for Individual Fixture Fittings.
    - g. 1017 - Temperature Actuated Mixing Valves for Hot Water Distribution Systems.
    - h. 1018 - Trap Seal Primer Valves – Potable Water Supplied.
    - i. 1044 - Trap Seal Primer Valves – Drainage Type.
    - j. 1072 – Performance Requirements for Barrier Type Trap Seal Protection for Floor Drains.
  - 3. ASTM Standards:
    - a. A53 - Steel Pipe, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
    - b. A74 - Cast Iron Soil Pipe and Fittings.
    - c. A181 - Carbon Steel Forgings for General Purpose Piping.
    - d. A194 - Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service.
    - e. A234 - Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
    - f. A307 - Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
    - g. A395 - Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
    - h. A518 - Corrosion-Resistant High Silicon Iron Castings.
    - i. B88 - Seamless Copper Water Tube.
    - j. B306 - Copper Drainage Tube (DWV).
    - k. C76 - Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
    - l. C564 - Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
    - m. D2136 - Test Method for Coated Fabrics - Low Temperature Bend Test.
    - n. D2657 - Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings.
    - o. D2665 - Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings.
    - p. D2751 - Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings.

- q. D3034 - Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
- r. D4101 - Propylene Plastic Injection and Extrusion Materials.
- s. F789 - Type PS-46 and PS-115 Poly(Vinyl Chloride) (PVC) Plastic Gravity Flow Sewer Pipe and Fittings.
- 4. AWWA Standards:
  - a. C500 - Gate Valves for Water and Sewerage Systems.
  - b. M20 - Water Chlorination Principles and Practices.
- 5. PDI (Plumbing and Drainage Institute) Standard: WH-201 - Water Hammer Arresters.
- 6. ARI Standard: 1010 - Drinking Fountains and Mechanically Refrigerated Drinking Water Coolers.
- 7. NSF/ANSI Standard 372 – Drinking Water System Components – Lead Content.

#### 1.4 SUBMITTALS

- A. Manufacturer's Literature: For all products required in Part 2 of this Section:
  - 1. Required Information:
    - a. General:
      - 1) Name of Manufacturer.
      - 2) Model number.
      - 3) Dimensions.
      - 4) Details of construction and installation.
  - 2. Not required for piping or hangers and supports.

#### 1.5 QUALITY ASSURANCE

- A. Fabrication and Installation Personnel Qualifications:
  - 1. Trained and experienced in the fabrication and installation of the materials and equipment.
  - 2. Knowledgeable of the design and the reviewed Shop Drawings.
- B. Regulatory Agencies Requirements:
  - 1. All state and local codes and ordinances shall have jurisdiction.
  - 2. All related electrical devices shall be housed in suitable enclosures as defined by the National Electrical Manufacturers' Association (NEMA).
  - 3. All gas-fired appliances and installation shall be in accordance with American Gas Association (AGA) guidelines.
  - 4. All components used in systems in contact with drinking water shall comply with the requirements of NSF 372 for lead free.

### PART 2 - PRODUCTS

#### 2.1 PIPE AND PIPE FITTINGS

- A. Comply with the requirements of Division 22 Sections "Steel Pipe and Fittings for Plumbing," "Cast Iron Pipe and Fittings for Plumbing," and "Copper Pipe and Fittings for Plumbing."
- B. Refer to schedules in Part 3 of this Specification for specific applications of pipe materials to plumbing systems.
- C. Refer to Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" and the schedule in Part 3 of this Section for Hanger and Support Requirements for Plumbing System Piping.

#### 2.2 SPECIALTIES

- A. Pipe Guides:
  - 1. Manufacturer:
    - a. ITT Grinnell.
    - b. Michigan Hanger.
    - c. Keflex.
  - 2. Type: Spider, P-series, Figure 25L.
  - 3. Minimum 12 inches long.
  - 4. Spacing: As indicated on Drawings or as required by Expansion Joint Association.

- B. Expansion Loops:
  - 1. Size: As indicated on Drawings.
  - 2. Material: ASTM A53 Grade "A" seamless steel pipe, schedule to match pipe.
  - 3. Long radius elbows.
  
- C. Strainers:
  - 1. Manufacturer: Armstrong, Mueller.
  - 2. Type: "Y".
  - 3. Screen: 20 mesh brass, removable.
  - 4. Area: 5 times pipe diameter.
  - 5. Pressure Rating: Match piping.
  - 6. Install in front of each modulating valve, pressure regulating valve, pump suction and where indicated.
  
- D. Basket Strainers:
  - 1. Manufacturer: Mueller Steam Specialty.
  - 2. Model: 125F.
  - 3. Cast iron body and cover, rated 200 psi W.O.G. with quick-release knobs and floor support.
  - 4. Basket: 0.057-inch perforated stainless steel (1/8-inch perforated on 5 inches and larger) removable with O-ring seal.
  - 5. Capacity: 6 to 1 open ratio.
  
- E. Manual Air Vents:
  - 1. Manufacturer: Bell & Gossett or Dole.
  - 2. Size: 1/8-inch.
  - 3. Type: Slotted head (Bell & Gossett 4V or Dole No. 9).
  - 4. Location: Wherever called for on Drawings.
  
- F. Shock Absorbers:
  - 1. Furnish and install where indicated or wherever quick closing valves (including flush valves) are utilized. Shock absorbers shall be located and sized in accordance with Standard PDI-WH-201.
  - 2. Manufacturer: Josam, Wade, or Zurn.
  
- G. Dielectric Water Fittings:
  - 1. Dielectric Couplings: Electroplated steel or brass nipple, with an inert and non-corrosive, thermoplastic lining.
  - 2. Dielectric Unions: Provide dielectric unions with appropriate end connections for the pipe materials in which installed (screwed, soldered or flanged), which effectively isolates dissimilar metals, prevents galvanic actions and stops corrosion.
  
- H. DWV Fitting Restraints
  - 1. Provide engineered fitting restraints on all no-hub DWV and storm pipe fittings greater than 4 inches. Pipe shall be restrained at all changes of pipe diameter greater than 2 pipe sizes and at all changes of direction with braces, blocks, rodding, or other suitable methods as specified by the coupling manufacturer.
  - 2. Provide engineered fitting restraints on all DWV and storm pipe no-hub fittings in buildings 2 stories and higher.
  - 3. Untested field provided restraints are unacceptable.
  - 4. Fitting restraints to be equal to HoldRite model #117 or similar.

## 2.3 VALVES

- A. General Duty Hand Valves: Refer to Division 22 Section "General Duty Valves for Plumbing" for valve construction and material requirements.
  - 1. Valves Up to 2-inches:
    - a. Shut-off: 150 lb bronze gate or full-port ball valve.
    - b. Throttling: 150 lb bronze globe.
  - 2. Valves 2-1/2-inches and Larger:
    - a. 125 lb IBBM OS&Y Gate Valve: Use only as required by local jurisdiction for water meter setting, all others shall be high performance all stainless-steel butterfly valves.
    - b. Shut-off: High performance butterfly valve, all stainless steel, rated for 175 psig and 250 degrees F, bubble-tight shutoff, lug type.

- B. Mixing Valves:
  - 1. ASSE 1070 Point of Use Thermostatic Control Valve:
    - a. Certified for compliance with ASSE 1070 for individual fixture temperature control.
    - b. Shall use a wax filled thermostatic element to sense incoming temperature fluctuations and maintain leaving water temperature 3 degrees F of setpoint for flows down to 0.5 gpm.
    - c. Construction:
      - 1) Cast bronze body.
      - 2) Stainless steel internal components.
      - 3) 125 psig rated working pressure.
    - d. Provide tamper resistant setpoint adjustment.
    - e. Provide with integral check valves.
    - f. Watts USG-B, Wilkin.
- C. Floor Drain Trap Seals:
  - 1. For applications with infrequent drain usage:
    - a. Provide inline drain trap seal, SureSeal Waterless Inline Drain Trap Seal. Green Drain Model GD Inline Drain Trap.
    - b. Must comply with ASSE 1072.
  - 2. Barrier-type:
    - a. Installed in accordance with Manufacturer's instructions. Must comply with ASSE 1072.
    - b. Manufacturer: Green Drain, IPS Corporation, Jay R, Smith, Rector Seal, Zurn.

2.4 BACKWATER VALVES

- A. Manufacturers:
  - 1. Josam Company.
  - 2. Jay R. Smith Manufacturing Company.
  - 3. Wade.
  - 4. Watts Industries, Inc.; Drainage Products Division.
  - 5. Zurn Industries, Inc.; Specification Drainage Operation.
- B. Horizontal Backwater Valves:
  - 1. ASME A112.14.1, cast iron body, with removable bronze swing-check valve and threaded or bolted cover.
  - 2. Extension: ASTM A74, service class; full size, cast iron, soil pipe extension to field installed cleanout at floor, instead of cover.

2.5 BACKFLOW PREVENTER

- A. Description:
  - 1. Furnish and install approved backflow preventer(s) in accordance with the following table and as indicated on Drawings. Include a safewaste drain for drip from preventer valves piped to floor drain and install strainers ahead of first gate valve:

Service	Size	Rating	Description
Domestic Water Services	3/4 - 8"	150#	Reduced pressure zone backflow preventer.
Fire Lines	3" - 8"	150#	Double check/double gate unit equal to Watts #709. Stainless steel check/double butterfly valve equal to Ames Maxim 200/300. Must be UL listed and FM approved.
Hose Bibbs	1/2" - 3/4"	150#	Single check with vacuum breaker equal to Watts #8 or #8A. Use #NF8 for frost proof hydrants
NOTE: Requirements of Codes having jurisdiction, that vary from the table requirements, shall be complied with for all services.			

- B. Manufacturer: Watts, Hersey, Beeco, Febco, Conbraco.

## 2.6 CLEANOUTS

### A. Description:

1. Furnish and install cleanouts where indicated on drawings in accordance with the following table. Cleanouts subject to vehicular traffic (hi-lo's, etc.) shall be heavy duty type. Wade model numbers are for reference only.
2. Series floor cleanout with NH spigot outlet or ty-seal outlet connection, threaded adjustable housing, flanged ferrule with tapered brass plug and round or square nickel brass or ductile iron vandal resistant secured top for floor finishes as follows:

Location	Wade Number
Unfinished Concrete (Scoriated XH Di Top)	W-6000-Z
Carpet (Textured NB Top with carpet marker)	W-6000-CM
Asphalt and Vinyl Tile (Recessed NB Top)	W-6000-TS
Ceramic and Quarry Tile (Scoriated NB Top)	W-6000-XS
Terrazzo (Deep recessed NB Top)	W-6000-U
Other LT Duty Finishes (Textures NB Top)	W-6000
Other XH Duty Finishes (Scoriated XH NB Top)	W-6000-X
Exterior Areas (Scoriated XH Di Top)	W-6000-Z
Vertical rough piping (exposed)	W-8560-E
Concealed piping in walls	W-8560-E with W-8304 - Round stainless steel cover with flush top.
Special Marking	W-6000-83

- B. Manufacturer: Wade, Zurn, Josam, Smith, MI-FAB.

## 2.7 FLOOR DRAINS AND SINKS

- A. Furnish and install floor drains at low point of sloped floor or at elevations indicated on the Drawings in accordance with the following.
1. Provide 4-inch deep seal traps on floor drains.
  2. Provide tapping for connection of trap seal primer line on floor drains.

### B. Description:

1. Floor Drains: Refer to Plumbing Fixture Schedule on Drawings for description and model information.

- C. Manufacturer: Wade, Josam, Zurn, Smith, MI-FAB, Watts.

## PART 3 - EXECUTION

### 3.1 DOMESTIC COLD AND HOT WATER SYSTEMS

- A. Description: Provide as indicated on the Drawings and as required to comply with all applicable codes and regulations, complete system of piping, fittings, valves, auxiliaries and accessories as required to connect cold and hot water to all items requiring cold or hot water.

### B. Pipe and Fittings:

1. Above Grade: Type L and drawn copper in accordance with ASTM B88 and Division 22 Section "Copper Pipe and Fittings for Plumbing." Exposed pipe and fittings at fixtures shall be chrome plated.
2. Below Grade: Type K soft temper copper in accordance with ASTM B88 and Division 22 Section "Copper Pipe and Fittings for Plumbing" (maximum pressure of 60 psig).

### C. Installation:

1. All interior piping shall be run square and straight with the building.
2. Piping in finished areas shall be concealed within walls, chases, enclosures, etc.
3. Piping in exposed areas shall be run as high as possible within joists and beam spaces, or below the floor as indicated on the Drawings.
4. Piping shall follow approved paths as shown or indicated on the Drawings. Connect to existing lines where required or to equipment in an approved manner. Locate pipes, valves and equipment accessible for maintenance, minimum obstruction of passage and work spaces.



5. Install drain valves at all low points in piping system.
6. Install all required trap primer systems and piping.
7. Provide unions at each screwed valve, unions, and at all points in the piping system where necessary to facilitate dismantling.

D. Hot Water Recirculation System:

1. Where indicated, furnish and install hot and tempered recirculating water systems; return to the cold water side of the heater and provide a gate valve and union in each line. Special requirements as detailed on the Drawings.
2. Provide supplemental angles, hangers and bracing required for the support of the equipment.
3. Provide balancing valves on recirculating system return branches to allow complete balancing of all branches.

### 3.2 BUILDING SANITARY DRAINAGE SYSTEM

A. Description: Furnish and install the sanitary drainage system as indicated on the Drawings. System includes, but is not necessarily limited to, the following items: Waste and vent piping for all plumbing, fixtures requiring same, floor drains, cleanouts.

B. Material:

1. Above and below ground piping as defined in Part 2 of this Section.
2. Drains and cleanouts as defined in Part 2 of this Section.

C. Installation:

1. General runs of sanitary sewer are indicated on Drawings diagrammatically and every bend, offset, etc., is not necessarily indicated, all of which must be installed to properly drain all stacks, fixtures, vents, etc.
2. Run horizontal waste lines at a minimum slope of 1/4-inch per foot for pipes less than 3 inches in diameter and 1/8-inch per foot for lines 3 inches and larger, unless indicated otherwise.
3. Connections between mains and laterals shall be made with wyes and 1/8 bends.
4. Changes in direction shall be with long radius ells except in stacks where sanitary tees and short radius 1/4 bends may be used in changes from horizontal to vertical.
5. Flash all vent stacks at the roof.
6. Cleanouts shall be installed where required by code and as indicated on the Drawings and specified herein. They shall be accessibly located, set flush with finish surface or finish grade, and shall be same nominal pipe size as line served, but no larger than 4 inches. Stainless steel flush cover plates required for wall accessed cleanouts.
7. Provide cleanouts located in waterproof above grade floors with flashing flange and clamp device. Flash with 60 mil PVC membrane minimum 4-foot square.
8. Furnish and install stack base fittings at the base of each riser set on a concrete or brick base on firm soil. All vertical risers shall be supported at floors.
9. Pitch vent lines to gravity drain to waste pipe.
10. Provide no-hub fitting restraints on piping greater than 4 inches and in all buildings 2 stories and taller.

### 3.3 CLEANING, TESTING, CHLORINATION

A. As piping material is erected, the inside of all piping shall be thoroughly cleaned of foreign material. Flush and test piping before operation in accordance with Division 22 Section "Testing and Cleaning of Plumbing Systems."

B. On completion of the domestic water piping systems, chlorinate the system using methods acceptable to and approved by Engineer. Furnish all chlorine and chlorinating equipment.

C. After system chlorination is complete, submit water Samples to the governing health department for testing. Take Samples as directed by Engineer, and provide Engineer with a letter from the governing health department indicating test results.

3.4 SCHEDULES

<b>Sanitary</b>				
System	Schedule	Material	Specifications	Remarks
<b>Underground</b>				
Sanitary: Minimum size 3 inches unless noted otherwise				
	S.V.	C.I.	ASTM A74	Bell & Spigot with Elastomeric Gasket or Lead & Oakum
	S.V.	C.I.	ASTM C564, A888	No Hub with Heavy Duty Couplings
<b>Above Ground</b>				
Sanitary	S.V.	C.I.	ASTM A74	Bell & Spigot with Elastomeric Compressive Gasket. Lead & Oakum
	S.V.	C.I.	ASTM C564, A888	No Hub
	DWV	Copper	ASTM B306	ANSI B16.23 Soldered

<b>Domestic Water Above Ground 125 PSI Maximum Pressure</b>					
Pipe Size	Schedule	Material	Spec	Grade	Remarks
1/4" – 6"	Type L	Copper	ASTM B88	--	Solder 95/5, Silvabrite
2" – 6"	Type L	Copper	AWS A5.8	--	Silver Solder/Brazed

<b>Domestic Water Below Ground</b>				
Pipe Size	Schedule	Materials	Spec	Remarks
1/2" – 2"	Type K	Soft Copper	ASTM B88	Flared Fittings

END OF SECTION 22 10 00

## SECTION 22 10 23 – NATURAL GAS PIPING 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.

#### 1.2 SUMMARY

- A. This Section includes the furnishing and installation of natural gas piping and related items:
  - 1. Natural gas distribution system.

#### 1.3 REFERENCES

- A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with the following:
  - 1. ANSI Z223.1 - Fuel Gas Code.
  - 2. ASME B31.1 - Power Piping.
  - 3. ASME B31.8 - Gas Transmission and Distribution Piping Systems.
  - 4. International Fuel Gas Code, latest edition.
  - 5. NFPA 54, National Fuel Gas Code, Latest Edition.

#### 1.4 QUALITY ASSURANCE

- A. Fabrication and Installation Personnel Qualifications: Trained and experienced in the fabrication and installation of the materials and equipment.
- B. Installation shall comply with:
  - 1. State and local codes and ordinances.
  - 2. Requirements of:
    - a. Owner's insurer.
    - b. Gas distribution utility.

#### 1.5 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials in original, unbroken, brand marked containers or wrapping as applicable.
- B. Handle and store materials in a manner which will prevent deterioration and contamination with foreign matter.
- C. Reject damaged, deteriorated, or contaminated material and immediately remove from the Site. Replace removed materials at no additional cost to Owner.
- D. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- E. During Freezing Weather:
  - 1. Protect all materials in such a manner that no harm can be done to:
    - a. Installations already made.
    - b. Materials and equipment on the Site.
- F. Furnish all necessary protection for such installations and equipment as may be required.

## PART 2 - PRODUCTS

### 2.1 PIPE AND FITTING APPLICATIONS:

- A. General:
  - 1. Comply with the requirements of Division 22 Section "Steel Pipe and Fittings for Plumbing."
  - 2. Pipe 6'-0" and longer shall be permanently marked with the following information:
    - a. Manufacturer's name.
    - b. Pressure rating.
    - c. Size.
  
- B. Natural Gas – To 30 psig:
  - 1. For Piping Through 2-Inch:
    - a. Pipe: Black Steel, Schedule 40, ASTM A53 or A106, seamless, Grade B.
      - 1) Fittings: Cast Iron, ASTM EB16.4, 150 pound.
      - 2) Joints: Screwed.
  - 2. For Piping 2-1/2-Inch and Larger:
    - a. Pipe: Black Steel, Schedule 40, ASTM A53 or A106, seamless, Grade B.
      - 1) Fittings: Schedule 40, Wrought Steel, ASTM B16.9, ASTM A234.
      - 2) Joints: Welded. Flanged ASTM A181, 150 pound, forged steel at valves, and equipment.

### 2.2 VALVES

- A. Plug Valves:
  - 1. Aboveground:
    - a. Plug valves (gas cock) for natural gas shutoff applications shall be lubricated type equal to Homestead Figure 611 or 612 or Rockwell Figure 114 or 115.
    - b. Valves 2-inch and smaller shall be threaded. Valves 2-1/2-inch and larger shall be flanged.
  - 2. Underground (Curb Type):
    - a. Plug valves (gas cock) for natural gas shutoff applications shall be lubricated type equal to Nordstrom Figure 1943 or 4185.
    - b. Valves shall be welding end.
    - c. Provide with adjustable tar coated cast iron extension shaft and flush box with extra heavy cast iron cover marked "GAS". Provide 2 operating handles.

### 2.3 PIPING SPECIALTIES

- A. Y-Pattern Strainers:
  - 1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
  - 2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
  - 3. Strainer Screen: 60 mesh startup strainer, and perforated stainless steel basket with 50% free area.
  - 4. CWP Rating: 125 psig.
  
- B. Weatherproof Vent Cap: Cast iron or malleable iron increaser fitting with corrosion resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded end connection.

### 2.4 PRESSURE REGULATORS

- A. General Requirements:
  - 1. Single stage and suitable for natural gas.
  - 2. Steel jacket and corrosion resistant components.
  - 3. Elevation compensator.
  - 4. End Connections: Threaded for regulators NPS 2 and smaller; flanged for regulators NPS 2-1/2 and larger.

- B. Line Pressure Regulators: Comply with ANSI Z21.80.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Actaris.
    - b. American Meter Company.
    - c. Eclipse Combustion Inc.
    - d. Fisher Control Valves and Regulators; Division of Emerson Process Management.
    - e. Invensys.
    - f. Maxitrol Company.
    - g. Richards Industries; Jordan Valve Division.
  2. Body and Diaphragm Case: Cast iron or die cast aluminum.
  3. Springs: Zinc plated steel; interchangeable.
  4. Diaphragm Plate: Zinc plated steel.
  5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion and deformation at the valve port.
  6. Orifice: Aluminum; interchangeable.
  7. Seal Plug: Ultraviolet-stabilized, mineral filled nylon.
  8. Single port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
  9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150% of design discharge pressure at shutoff.
  10. Overpressure Protection Device: Factory mounted on pressure regulator.
  11. Atmospheric Vent: Factory installed or field installed, stainless steel screen in opening if not connected to vent piping.
  12. Maximum Inlet Pressure: 5 psig.
- C. Appliance Pressure Regulators: Comply with ANSI Z21.18.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Canadian Meter Company, Inc.
    - b. Eaton Corporation; Controls Division.
    - c. Harper Wyman Company.
    - d. Maxitrol Company.
    - e. SCP, Inc.
  2. Body and Diaphragm Case: Die cast aluminum.
  3. Springs: Zinc plated steel; interchangeable.
  4. Diaphragm Plate: Zinc plated steel.
  5. Seat Disc: Nitrile rubber.
  6. Seal Plug: Ultraviolet stabilized, mineral filled nylon.
  7. Factory Applied Finish: Minimum 3 layers polyester and polyurethane paint finish.
  8. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.
  9. Maximum Inlet Pressure: 5 psig.

## PART 3 - EXECUTION

### 3.1 NATURAL GAS DISTRIBUTION SYSTEM

- A. Description of Work:
1. Extend existing natural gas distribution system as indicated on Drawings and as required to comply with applicable codes and regulations.
  2. This includes, but is not limited to, the following:
    - a. Vent lines to atmosphere where applicable.
    - b. Connect gas to equipment outlets.
    - c. Auxiliaries and accessories.
    - d. Provide gas pressure regulators at appliances and equipment designed to operate at a lower pressure than the supply pressure and as indicated on Drawings. Regulators shall be listed as compliant with ANSI Z21.80 Standard for Line Pressure Regulators.
- B. Aboveground and Indoor Piping and Installation:
1. Install gas piping and valves in accordance with the requirements of the International Fuel Gas Code, the gas company, and the NFPA 54 National Fuel Gas Code.
  2. Run gas piping and make final connections to equipment requiring gas.

3. Install gas cock and drip in branch laterals serving each piece of equipment.
  4. Gas pipe in inaccessible locations shall not have unions, valves, tubing fittings or running threads.
  5. 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.
  6. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
  7. Locate valves for easy access.
  8. Install natural gas piping at uniform grade of 2% down toward drip and sediment traps.
  9. Install piping free of sags and bends.
  10. Verify final equipment locations for roughing-in.
  11. Drips and Sediment Traps: Install drips at points where condensate may collect, including service meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.
    - a. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.
  12. Extend relief vent connections for service regulators, line regulators and overpressure protection devices to outdoors and terminate with weatherproof vent cap.
  13. Connect branch piping from top or side of horizontal piping.
  14. Eccentric fittings or eccentric reducing couplings shall be used to make reductions. Install fittings with level side down.
  15. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.
  16. Install strainer on inlet of each line pressure regulator and automatic or electrically operated valve.
  17. Install pressure gage upstream and downstream from each line regulator.
- C. Connections:
1. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas fired appliance and equipment. Install union between valve and appliances or equipment.
  2. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

END OF SECTION 22 10 23

## SECTION 22 40 00 – PLUMBING FIXTURES

### 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 furnishing and installation of plumbing fixtures.
- B. Division of Work:
  - 1. In accordance with the General Conditions, Contractor is responsible for dividing the Work among the Subcontractors and Suppliers and for delineating the work to be performed by specific trades.
  - 2. The following are suggestions as to how the Work may be divided. This is not a complete list of all the work:
    - a. General Contractor: Install or arrange for installation of all fixture supports and carriers as directed by mechanical Subcontractor.
    - b. Mechanical Subcontractor:
      - 1) Furnish all required fixture supports and carriers.
      - 2) Instruct General Contractor regarding location and installation of supports and carriers.
      - 3) Be responsible for proper rough-in locations and dimensions.
    - c. Faucet Manufacturer: Provides remote transformers for barrier free special trim.
    - d. Electrical Subcontractor: Installs transformers for barrier free special trim.

#### 1.3 REFERENCES

- A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with the following:
  - 1. ANSI Standard:
    - a. A112.18.1 - Finished and Rough Brass Plumbing Fixture Fittings.
    - b. A112.19.2 - Vitreous China Plumbing Fixtures.
    - c. A112.19.3 - Stainless Steel Plumbing Fixtures.
    - d. A112.19.5 - Trim for Water Closet Bowls, Tanks & Urinals.
    - e. A117.1 - Buildings and Facilities - Providing Accessibility and Usability for Physically Handicapped People.
    - f. Z358.1 - Standard for Emergency Eyewash and Shower Equipment.
  - 2. ARI - Air Conditioning and Refrigeration Institute - Standard: Drinking Fountains and Self-Contained, Mechanical Refrigerated Drinking Water Coolers.
  - 3. ADA - Americans with Disabilities Act.
  - 4. ASSE - American Society of Sanitary Engineering.

#### 1.4 SUBMITTALS

- A. Manufacturer's Literature: For fixtures.
  - 1. Model number/name.
  - 2. Manufacturer's name.
  - 3. Dimensions.
  - 4. Color/finish.

#### 1.5 QUALITY ASSURANCE

- A. Installing personnel shall be adequately trained and experienced in the installation of the materials and equipment.

- B. Regulatory Requirements:
1. Comply with 2021 International Plumbing Code and all amendments there to as defined in Part 7, Plumbing Code Rules as published by the Michigan Department of Labor Construction Code Commission.
  2. Installation shall comply with Americans with Disability Act (ADA) regarding type of fixtures and trim, height and clearance requirements, and safety components and systems.
  3. Comply with the State of Michigan barrier free design requirements as published by the Michigan Department of Labor Construction Code Commission.
  4. Comply with Americans for Disability Laws.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURER

- A. Fixtures: American Standard, Kohler, Elkay.
- B. Flush Valves: Sloan.
- C. ADA Drain and Water Line Safety Covers at Lavatories and Sinks:
1. Handy shield safety covers, Plumberex Specialty Products, Cathedral City, CA.
  2. Handi Lav-Guard, Truebro, Inc., Ellington, CT.
- D. Faucets: Delta.
- E. Fixture Carriers: Wade, Josam, Zurn, Sioux Chief, Watts.

### 2.2 GENERAL

- A. Traps:
1. Equip fixtures with traps (with cleanouts) unless indicated otherwise, of the same size as the fixture connection.
  2. P-traps (above grade): Cast brass, adjustable, with a cleanout plug and 17 gage tubing outlet, chrome plated.
  3. Size branch lines as indicated.
- B. Assemblies:
1. Where fixtures are described by a Manufacturer's assembly number, furnish the complete assembly.
  2. Additional items not ordinarily furnished in the assembly will be indicated or noted.
- C. Where roughing-in or installing fixtures and equipment furnished by other trades, provide required stops, supplies and traps, as well as rough-in, installation, and connecting work.
- D. Finishes:
1. Vitreous China Fixtures: White, unless specifically noted otherwise.
  2. Stainless Steel Fixtures: 20 gage minimum, Type 302, nickel bearing stainless steel, unless otherwise noted.
  3. Trim, fittings, traps, etc., where exposed to view: Heavy chrome plated.

### 2.3 WATER CLOSETS, URINALS AND LAVATORIES

- A. Refer to the schedules on the Drawings for specific applications and the basis of design selections.
- B. Fixture Carriers:
1. Manufacturer: Wade, Zurn Josam, or Smith, Watts.
  2. Requirements:
    - a. Secure wall mounted lavatories into position by means of carriers specifically manufactured for the fixture installed.
    - b. Carriers shall be of proper size to fit within the space allotted.
  3. Supports: Provide adequate internal supports for wall mounting brackets.



- C. Barrier Free Special Trim:
  - 1. Lavatory faucet activates water flow only when the user's hands enter infrared detection zone.
  - 2. Faucet turns itself off after the hands are removed from detection zones.
  - 3. Incoming water shall be tempered with thermostatic mixing valve.
  - 4. Tempered water shall not exceed 105 degrees F.
  - 5. Thermostatic mixing valve and solenoids shall be contained in recessed stainless steel No. 304, 18 gage cabinet, with 16 gage door and key.
  - 6. Barrier free lavatories shall have water supply tempered with an ASSE 1070 device.
  - 7. ADA approved drain and water safety covers are required on all exposed piping under barrier free lavatories.

#### 2.4 SERVICE SINKS AND SINKS

- A. Refer to schedules on the Drawings for specific applications and the basis of design selection.
- B. If sink is ADA compliant or used for handwashing, incoming water shall be tempered with approved thermostatic mixing valve.

#### 2.5 MISCELLANEOUS PLUMBING APPLIANCES

- A. Refer to the schedules on the Drawings for specific applications and the basis of design selection.
- B. Domestic water coolers.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Install fixtures at proper heights in accordance with applicable codes and as indicated on the Drawings.
- B. Point up around fixtures where they abut a wall or floor unless so directed by Engineer.
- C. Securely fasten fixtures to the floor, wall, or counter. Fixtures shall be level and square.
- D. Follow Manufacturer's instructions for fixture installations, especially for grouting and caulking.

#### 3.2 INSPECTION

- A. Inspect each fixture and unit for damage to finish.
- B. Remove and replace cracked, dented units and units or items unable to be repaired or restored to a condition acceptable to Engineer.

#### 3.3 CLEANING

- A. Thoroughly clean by washing with soap and disinfectant solution on all plumbing fixtures.
- B. Remove, clean, and reinstall aerators.

END OF SECTION 22 40 00

## SECTION 23 01 00 – OPERATION AND MAINTENANCE OF HVAC 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. Refer to individual Division 23 sections for additional equipment specific Operations and Maintenance Manual requirements.

#### 1.2 SUMMARY

- A. This Section includes preparing and furnishing an operating and maintenance manual for mechanical equipment.

#### 1.3 DESCRIPTION

- A. Compile an Operating and Maintenance Manual:
  - 1. For all building mechanical systems and major equipment items.
  - 2. Including, but not necessarily limited to:
    - a. Installing company's name, address, telephone number and name of job supervisor.
    - b. Maintenance and operating booklets (as supplied by the equipment Manufacturer) for each item or representative type item installed.
    - c. Valve tag schedule.
    - d. A complete set of Shop Drawings.
    - e. Temperature control drawings.
    - f. Equipment information forms for each equipment piece.
  - 3. Each equipment information form include all applicable items of the following:
    - a. Type of unit.
    - b. Manufacturer's name.
    - c. Equipment service area.
    - d. Filter Information:
      - 1) Filter change period.
      - 2) Type of filter.
      - 3) Size of filter and number.
    - e. Motor and Drive Information:
      - 1) Belt type and quantity.
      - 2) Belt size.
      - 3) HP.
      - 4) Voltage.
      - 5) Phase.
    - f. Lubrication Information:
      - 1) Recommended service interval.
      - 2) Lubricant application points.
      - 3) Recommended lubricant type.
    - g. Recommended cleaning procedures and intervals.
- B. Prepare Information Packets:
  - 1. Attach to each major piece of equipment in a string tie envelope labeled with the equipment's designation in large print.
  - 2. Information Required:
    - a. A copy of the equipment information form as defined above.
    - b. A temperature control written operation sequence.
    - c. A maintenance checklist form with equipment identification information and listing all relevant maintenance procedures in a column format to accommodate date entries.

1.4 SUBMITTALS

- A. Three hard copies of Operating and Maintenance Manual.
- B. PDF Electronic File: Include a complete electronically linked operation and maintenance directory.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

Not used.

END OF SECTION 23 01 00

## SECTION 23 05 00 – GENERAL HVAC PROVISIONS

### 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 specifying the general requirements for execution of that portion of the Work defined in Division 23 of these Specifications and as indicated on the Drawings:
  - 1. Major items include, but are not necessarily limited to:
    - a. Cutting and patching.
    - b. Concrete foundations and support steel.
    - c. Piping, fittings, and valves.
    - d. Piping, ductwork, and equipment insulation.
    - e. Piping, ductwork, and equipment painting.
    - f. Temperature and pressure gages.
    - g. Excavation and backfilling required.
    - h. HVAC equipment, including drives.
    - i. Ductwork.
    - j. Temperature control systems.
    - k. Demolition of existing mechanical work.
    - l. Labor, materials, equipment, tools, supervision, and start-up services.
    - m. Mechanical systems testing, adjusting, and balancing.
    - n. Mechanical systems commissioning.
    - o. Instructions to Owner regarding operation.
    - p. Incidental and related items necessary to a complete and functionally operational installation of the Work.
- B. Division of Work: In accordance with the General Conditions, Contractor is responsible for dividing the Work among the Subcontractors and Suppliers and for delineating the Work to be performed by specific trades. The following are suggestions as to how the Work may be divided. This is not a complete list of all the Work:
  - 1. General Contractor:
    - a. Install access doors.
    - b. Provide concrete isolation and housekeeping pads for mechanical equipment.
    - c. Refer to Division 01 Section "Cutting and Patching."
    - d. Provide access doors in walls and ceilings for access to mechanical equipment.
  - 2. Mechanical Subcontractor:
    - a. Refer to Division 01 Section "Cutting and Patching."
    - b. Furnish location, size, and quantity of openings to Contractor before construction of new walls, ceilings, and floors.
    - c. Furnish size and locations of concrete equipment isolation and housekeeping pads as required for this Work and as indicated on the Drawings to Contractor before slabs are poured.
    - d. Furnish size and location of access doors required for this work as indicated on the Drawings to Contractor.
    - e. Provide excavation and backfilling required in connection with the Work of Division 23.
    - f. Provide miscellaneous structural steel required in connection with support of the Work of Division 23.
    - g. Perform final cleaning of mechanical systems and equipment.

### 1.3 REFERENCES

- A. Except as herein specified or as indicated on the Drawings, the work of Division 23 shall comply with the following:
  - 1. ANSI: A13.1 - Standard for the Identification of Piping Systems.
  - 2. ASME - American Society of Mechanical Engineers:
    - a. B31.1 - Power Piping.
    - b. B31.9 - Building Services Piping.
    - c. Boiler and Pressure Vessel Code:
      - 1) Section I.
      - 2) Section II.
      - 3) Section IV.
      - 4) Section VIII.
  - 3. ASTM: A325 - Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
  - 4. International:
    - a. Current Building Code including state amendments.
    - b. Current Mechanical Code including state amendments.

### 1.4 DESIGN AND PERFORMANCE REQUIREMENTS

- A. Construction details, components, accessories, sizes and model numbers indicated on the Drawings or in these specifications are used to indicate minimum levels of quality and coordination requirements.
- B. Design and layout, including clearances and service access, are based on Manufacturer, model and components as scheduled or otherwise indicated on the Drawings. Other listed approved Manufacturer's components and equipment are acceptable provided the following conditions are satisfied:
  - 1. Meet minimum requirements listed in specifications or on Drawings, be compatible with facility and intended use, and meet requirements for a functional system.
  - 2. Present to Engineer documentation verifying that all the above conditions are satisfied at least 10 days prior to bid receipt date.
  - 3. Meet all sound criteria as listed. Additional sound attenuation materials may be used if required.
  - 4. Coordinate and pay for all changes resulting from the use of alternate equipment and components:
    - a. Coordinate and pay for all resulting work in other trades, including redesign efforts.
    - b. Make all duct and piping system changes required in utilizing alternate equipment. Changes must reflect building conditions, ceiling spaces, chase sizes, structure locations.
    - c. Obtain Engineer's prior approval for all changes to layout, clearances, components and service access proposed.
- C. Drawings:
  - 1. Are diagrammatic and indicate general arrangement of systems and work included.
  - 2. Do not necessarily indicate every required valve, fitting, trap, thermometer, gage, duct, elbow, transition, offset turning vane, mounting support and access panel.
  - 3. Shall not be scaled for measurement or installation location.
  - 4. Shall not serve as Shop Drawings.
- D. Schedules and model numbers shall not be used to:
  - 1. Serve as final, definitive quantity requirements. Contractor shall make own count as indicated on Drawings.
  - 2. Determine proper type or model with arrangement, mounting and accessories applicable.
- E. Coordinate installation work of Division 23 with work of other trades to provide a complete and functional system. Generally, the location of ductwork, sanitary, storm and vent piping take precedence over fire protection and HVAC piping, electrical conduit and cable trays.

### 1.5 PRODUCT UNLOADING AND HANDLING

- A. Unload equipment and materials required for completion of the Work.

- B. Handle and store equipment and materials carefully to prevent damage. Method of rigging and handling shall be subject to the approval of an authorized representative of the equipment Manufacturer whose equipment is being handled.

#### 1.6 TROUBLESHOOTING

- A. By Contractor: If, during the start-up or warranty period, mechanical systems operational problems occur for which the root cause is not readily apparent, Contractor shall promptly, through a Subcontractor or other resource designated by Subcontractor, provide diagnostic and investigative services to determine the cause or causes.
- B. By Engineer:
  - 1. At Contractor's request, Engineer will provide the services necessary to determine the cause or causes of the operational problems.
  - 2. Under the provisions of the General Conditions, Engineer will also provide these services if Contractor fails to respond satisfactorily to operational problems within a reasonable time after written notice from Engineer.
  - 3. If while working at Contractor's request or under the provisions of the General Conditions, Engineer determines that the problems are due to failure of the Work to comply with the requirements of the Contract Documents, Owner will compensate Engineer for additional services and deduct the amount paid from payment or payments to Contractor.

#### 1.7 UNACCEPTABLE WORK AND OBSERVATION REPORTS

- A. Work shall be unacceptable when found to be defective or contrary to the Drawings, Specifications, Codes specified or accepted standards of good workmanship.
- B. The Contractor shall promptly correct all work found unacceptable by the Architect/Engineer whether observed before or after substantial completion and whether or not fabricated, installed or completed. The Contractor shall bear all costs of correcting such unacceptable work, including compensation for the Architect's/Engineer's additional services made necessary thereby.
- C. During the course of construction, the Engineer will prepare "Field Visitation" Reports with a list of items found to be in need of correction. All items listed shall be corrected by the Contractor. A space is provided on the form for the Contractor to note the completion of each item. All prior "Field Visitation" Report items must be completed, the lists signed and returned to the Engineer prior to making the final inspection. After the final list is issued, the same procedure will apply.

#### 1.8 MAINTENANCE

- A. Special Tools: Where special tools are required for operation, furnish these to Owner.
- B. Loose and Detachable Parts:
  - 1. Retain loose and small detachable parts of the apparatus and equipment furnished until the completion of the Work.
  - 2. Turn over these parts to Owner.
- C. Start-up Filters:
  - 1. Do not run air handling equipment without filters.
  - 2. Use of installed permanent heating and cooling equipment ductwork systems shall be in accordance with Division 01 Section "Temporary Facilities and Controls."
  - 3. Provide temporary filters as required to protect the air handling systems during construction phase work.
  - 4. Just prior to Substantial Completion, replace temporary construction filter elements with the specified filter systems filter elements in accordance with Division 23 Section "HVAC Air Cleaning Devices."
- D. Permanent Heating and Cooling Equipment:
  - 1. Notify Engineer when installed and proposed to be used to heat building interior.
  - 2. Prior to using, provide adequate means to keep internal duct and acoustic liner surface clean and in a like-new condition.

3. Install temporary thermostats/sensors to operate the units until temperature control installation is completed.
4. Filters:
  - a. In accordance with Division 23 Section "HVAC Air Cleaning Devices."
  - b. Securely supported at each return and exhaust air open duct end and grille.
  - c. Support filter length at required intervals to prevent filter deformation.
  - d. Replaced at intervals required to keep internal duct and acoustic duct lining free of construction debris and dust.
5. If the HVAC units and ductwork are found to be dirty at the time of Owner occupancy or at any time, the Contractor will clean the units to the Owner and Engineer's satisfaction. The cleaning may include but not be limited to the following:
  - a. Steam cleaning of coils.
  - b. Vacuum cleaning of ductwork and/or interior of unit.
  - c. Brushing and vacuuming of fan wheels.

#### 1.9 SUBSTITUTIONS

- A. The Base Bid shall be based on equipment as specified. Where items are mentioned thusly, "may be furnished at the Contractor's option", the Contractor may use any one of the items named for their Base Bid. Proposals for substitutions are welcomed, but must be noted separately from the Base Bid and applied for in writing at Bid submittal.
- B. Where the Contractor furnishes equipment or material specified as equal or which is accepted as a substitution, they are responsible for all modifications required for their work, and work of all other trades to install the equipment and ensure performance as originally specified.
- C. Equipment and materials furnished as equal or as a substitution must be equal in quality, design, features, performances, arrangement, and appearance to that specified as standard.

### PART 2 - PRODUCTS

#### 2.1 FABRICATIONS

- A. Miscellaneous Structural Steel:
  1. Comply with the requirements of Division 05 Section "Metal Fabrications," where applicable.
  2. Structural steel work shall be done in accordance with the AISC Specification for Design, Fabrication and Erection of Structural Steel for Buildings, except that allowable stresses shall be reduced 25%.
  3. Where required, high strength structural steel bolting conforming to ASTM Specification A325 and assembled to AISC "Specifications for Assembly of Structural Joints. Using High Strength Steel Bolts" or welding shall be used in place of rivets.
  4. Connections shall be properly designed for the type of connection and the loads to be carried, and shall be subject to Engineer's or Owner's approval.
  5. Welding shall be done by operators who have been previously qualified by tests as prescribed in the American Welding Society "Standard Qualification Procedure" to perform the type of work required.
  6. Welding techniques shall conform to the American Welding Society "Code for Arc and Gas Welding in Building Construction", Section 4, Workmanship.
  7. Finished members shall be true to line and free from twist, bends and open joints.
- B. Material installed in a ceiling plenum shall be either noncombustible or have a maximum flame spread of 25 and a maximum smoke developed rating of 50.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Character of Work: Installation shall be executed in a workmanlike manner and shall present a neat mechanical appearance when completed.

B. Laying Out of Work:

1. Layout piping, ductwork, equipment and components in accordance with the Contract Documents and the Manufacturer's recommended practice, including provision of adequate space for maintenance. Review layout with Engineer prior to installation.
2. Check drawings of other trades to verify spaces in which work will be installed. Maintain maximum head room and space conditions at all points. Where head room or space conditions appear inadequate, notify Engineer before proceeding with installation.
3. If directed by Engineer, Contractor shall make reasonable modifications in the layout as required to permit proper execution of the Work and to prevent conflict with work of other trades.
4. Work shall be installed so as to be ready for operation, maintenance and repair. Minor deviations from Drawings may be made to accomplish this. Changes shall not be made without approval of Engineer.
5. Unless indicated otherwise, install piping and ductwork concealed above ceilings or within walls.

3.2 MODIFICATIONS TO EXISTING FACILITIES

- A. Prior to making connections to existing piping for reuse, confirm that existing piping being tied into is active for reuse.
- B. Comply with the requirements of Division 02 Section "Selective Demolition," for all work related to the modification, alteration, conversion, renovation, and reuse of existing facilities.

3.3 PIPE FITTINGS

- A. Provide insulating couplings or unions where dissimilar materials are joined.
- B. Provide unions at valves and at equipment for making repairs.
- C. Bull head connections in any piping service are expressly prohibited.

3.4 PAINTING

- A. Paint exposed, insulated and non-insulated piping, ductwork, and equipment, in accordance with the requirements of Division 09 – Finishes.
- B. Provide labels as specified below. Comply with OSHA "Safety Color Code for Marking Physical Hazards" and ANSI A13.1 for pipe labels and colors.
- C. Valves, Fittings, and Supports:
  1. Paint valves and fittings the same base color as the pipe they adjoin.
  2. Paint floor stands the same base color as the pipe they adjoin.
  3. Paint exposed brackets, supports, framing members and pipe hangers the same base color as the adjacent wall, ceiling, floor or roof deck, or gray, if adjacent surface is not painted.

3.5 CODING AND TAGGING

- A. Piping:
  1. Applied to new piping after installation, insulation, and final painting.
  2. Conform to Owner's existing standards or conventions.
  3. Markings:
    - a. Painted on, 1-inch high black letters.
    - b. Color coded band, conforming to ANSI A13.1.
    - c. Directional arrow.
  4. Place markers at 20-foot centers with at least 1 in each room and at each change in direction.
  5. Plastic coated "Set Mark-Snap-Around" pipe markers manufactured by Seton Name Plate Corp., New Haven, Connecticut; or approved equal, may be used in lieu of painted markers and bands.



- B. Valves:
1. Provide brass or minimum 1/16-inch thick laminated plastic tags indicating assigned valve number on valves.
  2. Furnish schedule(s) of tagged valves with number, location and purpose of each valve.
  3. Place a copy of each schedule:
    - a. In the Maintenance Instructions.
    - b. In a string tie envelope labeled "Valve Schedule" and mount on the wall in Janitors Closet.
- C. Where valves, dampers, fans, and terminal units are located above the ceilings, a cadmium plated screw or such marking as designed by Engineer shall be located in the ceiling tile directly below the device.
- D. Provide record documentation of all hydronic system air vent locations on record drawings (as-builts) or other method as approved by Engineer.
- E. Equipment:
1. Provide for:
    - a. Each rooftop unit and exhaust fan.
    - b. Labeled with its tag name/number as given on the Drawings.
    - c. Use 2-inch high stenciled painted lettering.
  2. Similarly label control components associated with the above named equipment items.
- F. Dampers:
1. Provide for each fire damper, combination fire/smoke damper, smoke damper, and balancing damper.
  2. Label shall bear the tag name and number as indicated on the Drawings.
  3. Use 2-inch high stenciled black lettering.
  4. Mark balancing damper location after final adjustment.

### 3.6 START-UP

- A. Comply with the requirements of Division 01 Section "Starting and Adjusting."

### 3.7 ADJUSTING

- A. Adjust and align equipment for smooth operation:
1. Plumb true and with parts in proper position and alignment.
  2. Rotating parts shall turn freely and in the correct direction.
  3. Flexible couplings shall be checked for alignment subject to Owner's approval.
  4. Follow Manufacturer's instructions.
- B. The work of installation shall be executed in conformity with the best practice, so as to contribute to efficiency of operation, minimum noise or vibration, minimum maintenance, accessibility and sightlines.

### 3.8 FIELD QUALITY CONTROL

- A. Manufacturer's Field Services:
1. Provide when required by individual Section.
  2. Provide the following services except where indicated otherwise in individual Sections:
    - a. Inspect, check and approve system installation.
    - b. Supervise system start-up.
    - c. Provide written report indicating that system:
      - 1) Has been properly installed and lubricated.
      - 2) Is in accurate alignment.
      - 3) Is free from undue stress imposed by connecting lines or anchor bolts.
      - 4) Has been satisfactorily operated under full load conditions.
    - d. Demonstrate operation of system to Owner's personnel.
    - e. Instruct Owner's personnel on operation and maintenance of system.

- B. Performance Test:
  - 1. Test the entire Work, including all of its individual systems for 2 weeks before final payment will be made.
  - 2. Every phase of plumbing, air conditioning and heating and ventilating plant shall be operated separately, or in conjunction one with the other to demonstrate to Engineer the ability of the plant to meet capacity and performance requirements while maintaining design condition, in accordance with the true intent and purpose of these Specifications.
  - 3. Make final tests in the presence of Owner and Engineer.
  - 4. If a part of the Work or equipment does not meet Specifications:
    - a. Correct the situation.
    - b. Obtain approval of Engineer before final payment is made.
  - 5. Provide the personnel and bear costs for correcting malfunctions.
  - 6. Owner will provide operating personnel and utilities.
  - 7. Air systems balancing shall be completed prior to performance testing.
- C. Comply with the requirements of Division 01 Section "Starting and Adjusting."

### 3.9 CLEANING AND FINISHING

- A. Comply with the requirements of Division 01 Section "Cleaning and Waste Management."
- B. Entire installation shall be free from surface oil and grease before work will be considered for final payment.
- C. After tests have been made and the system pronounced tight:
  - 1. Clean piping and equipment.
  - 2. Lubricate bearings.
- D. Final cleaning includes but is not limited to the following:
  - 1. Equipment with Factory Finishes:
    - a. Wash factory-finished equipment with mild soap and water and leave in first-class condition, entirely free of stains or streaks.
    - b. Do not use abrasive materials.
    - c. Touch up scratches or other violations of the factory finish paint with matching paint from the equipment Manufacturer.

END OF SECTION 23 05 00

## SECTION 23 05 13 – COMMON MOTOR REQUIREMENTS FOR HVAC 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 the furnishing and installation of all electric motors required for Division 23 specified equipment.

#### 1.3 REFERENCES

- A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with the following:
  - 1. NEMA - National Electrical Manufacturers Association - Standards and publications governing the following performance criteria:
    - a. Frame design.
    - b. Torque.
    - c. Enclosures.
    - d. Dimensions.
    - e. Power supply and voltages.
    - f. Locked rotor KVA per horsepower.
    - g. Service factor.
    - h. Sound power levels.
  - 2. NFPA 70 - National Electrical Code.
  - 3. ASHRAE 90.1 – 2019 Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings, with state amendments.

#### 1.4 SUBMITTALS

- A. Manufacturer's Literature:
  - 1. All polyphase motors.
  - 2. All motors 3 horsepower (name plate) and larger.
  - 3. All Motors:
    - a. Name and manufacturer.
    - b. Type and model.
    - c. Rated size.
    - d. Type of bearings.
    - e. Weight.
    - f. AFBMA Rating
  - 4. Lubrication and maintenance instructions.

#### 1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacture of electric motors and their accessories, with minimum 3 years documented product development, testing, and manufacturing experience.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect motors stored onsite from weather and moisture by maintaining factory covers and suitable weatherproof covering.
- B. For extended outdoor storage, remove motors from equipment and store separately in a protected area.

1.7 WARRANTY

- A. Provide 2 year Manufacturer's warranty.
- B. Provide with bearing warranty for lifetime of motor.

PART 2 - PRODUCTS

2.1 MANUFACTURER

- A. Reliance.
- B. Magnetek.
- C. Baldor.
- D. Lincoln Electric.
- E. Subject to compliance with specifications, motors drawing less than 250 watts and intended for intermittent service may be supplied by an alternate Manufacturer commonly used by the equipment Manufacturer.

2.2 SPEED (EXCEPT WHERE NOTED OTHERWISE)

- A. 1,800 rpm.
- B. Constant speed.

2.3 CONSTRUCTION

- A. Designed for continuous operation in 40 degree C environment, Class B insulation. Motors interconnected with a variable frequency drive shall be provided with Class F insulation and shall be inverter duty rated, and shall be outfitted with shaft grounding kit or isolated bearings bearing protection ring.
  - 1. Bearing protection ring shall be Type SGR as manufactured by Aegis; or approved equal.
- B. All copper windings with a minimum service factor of 1.15 for totally enclosed, fan-cooled (TEFC) and 1.25 for open, drip-proof (ODP) motors.
- C. NEMA frame, arrangement, and design as required for the specific application.
- D. Permanently lubricated unless specifically noted otherwise.
- E. Comply with all requirements for UL approval and labeling for specific hazard classification where explosion-proof and severe duty motors are indicated.
- F. Provide a visible stainless steel nameplate indicating:
  - 1. Motor horsepower.
  - 2. Voltage.
  - 3. Phase.
  - 4. Cycles.
  - 5. RPM.
  - 6. Full load amps.
  - 7. Locked rotor amps.
  - 8. Frame size.
  - 9. Manufacturer's name and model number.
  - 10. Service factor.
  - 11. Power factor.
  - 12. Efficiency: Nameplate motor efficiency shall be identified in accordance with NEMA and ASHRAE 90.1 standards.

- G. Except as specifically noted, all motors shall be high efficiency as listed in ASHRAE 90.1 for all motors 1 horsepower and larger: All efficiency ratings are to be as tested in accordance with IEEE Spec. 112, Method B.
- H. Electrical Connection: Conduit connection boxes, threaded for conduit. For fractional horsepower motors where connection is made directly, provide screwed conduit connection in end frame.
- I. Variable frequency drive units and motors shall be matched for proper operating characteristics.

## 2.4 VOLTAGE AND MOTOR TYPE

- A. Special conditions and voltage are noted on the Drawings.
- B. Electronically Commutated (EC) Motor:
  - 1. Specifically designed for fan applications.
  - 2. Permanently lubricated with heavy duty ball bearings to match fan load and prewired to specific voltage and phase.
  - 3. Internal motor circuitry shall convert AC power supplied to fan to DC power for motor operation.
  - 4. Speed controllable down to 20% of full speed (80% turndown).
  - 5. Minimum 85% efficient at all speeds
- C. Single Phase Power - Split Phase Motors:
  - 1. Starting Torque: Less than 150% of full load torque.
  - 2. Starting Current: Up to 7 times full load current.
  - 3. Breakdown Torque: Approximately 200% of full load torque.
- D. Single Phase Power - Permanent-Split Capacitor Motors:
  - 1. Starting Torque: Exceeding 1/4 of full load torque.
  - 2. Starting Current: Up to 6 times full load current.
  - 3. Multiple Speed: Through tapped windings.
- E. Single Phase Power - Capacitor Start Motors:
  - 1. Starting Torque: Three times full load torque.
  - 2. Starting Current: Less than 5 times full load current.
  - 3. Pull-Up Torque: Up to 350% of full load torque.
  - 4. Breakdown Torque: Approximately 250% of full load torque.
  - 5. Motors: Capacitor in series with starting winding; capacitor-start/capacitor-run motors shall have two capacitors in parallel with run capacitor remaining in circuit at operating speeds.
- F. 3-Phase Power - Squirrel Cage Motors:
  - 1. Starting Torque: One to one and one-half times full load torque.
  - 2. Starting Current: Six times full load current.
  - 3. Power output, locked rotor torque, breakdown or pullout torque: NEMA Design B characteristics.
  - 4. Design, construction, testing, and performance: Conform to ANSI/NEMA MG 1 for Design B motors.
  - 5. Insulation System: NEMA Class B or better.
  - 6. Motor Frames: NEMA standard T-frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.
  - 7. Bearings:
    - a. Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum AFBMA 9, L-10 life of 20,000 hours.
    - b. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension.
    - c. Stamp bearing sizes on nameplate.
  - 8. Sound Power Levels: To ANSI/NEMA MG 1, 75 dBA SPL at 3 feet maximum.
  - 9. Nominal Power Factor: Meet or exceed values in Schedules at full load and rated voltage when tested in accordance with ANSI/IEEE 112.

## 2.5 RATINGS

- A. Motors shall meet NEMA standards and be capable of operating at rated load with a voltage variation of  $\pm 10\%$ , a variable of  $\pm 5\%$  in rated frequency, or a combined variation of 10% without damage to the motor.
- B. Motors shall be selected for the type of service involved and shall be selected at a minimum of 15% above the required rating of the equipment served. (Does not include service factor.)

## 2.6 BELT DRIVES

- A. Belt drive motors shall be provided with adjustable sheaves with the selected equipment speed occurring at the midpoint of the adjustable range. Install belt guards over drives in accordance with OSHA requirements.

## 2.7 THERMAL OVERLOADS

- A. Provide built-in thermal overloads on all fractional horsepower motors.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. All materials and equipment shall be installed in accordance with Manufacturer's recommended installation methods for obtaining conformance with the Contract Documents.
- B. Alignment of all motors, factory coupled or mounted, and all motors field coupled and mounted, shall be rechecked after all connections have been made and after 48 hours of operation in designed service.
- C. Verify the voltage characteristics of each motor prior to ordering.
- D. Verify the correct wire connections and rotation of equipment by "bumping" motor after wiring.
- E. Confirm voltage imbalance on 3-phase motors is less than 2%.

### 3.2 APPLICATION: Except as specifically indicated, motors shall be selected as follows:

- A. Shaded pole motors are not acceptable.
- B. Phase, except where noted otherwise:
  - 1. 1/2 HP and Less: Single-phase.
  - 2. Larger than 1/2 HP: Three-phase.
- C. Single Phase Starting:
  - 1. 1/8 HP and Less: Split phase or permanent split capacitor.
  - 2. Greater than 1/8 HP: Capacitor start.
- D. Enclosure:
  - 1. Totally enclosed fan-cooled (TEFC) for all motors located outside, in wet areas, in mechanical rooms, or elsewhere as indicated.
  - 2. Open drip-proof (ODP) for motors located elsewhere, in a clean, dry environment.

END OF SECTION 23 05 13

## SECTION 23 05 29 – HANGERS AND SUPPORTS FOR HVAC PIPING, DUCTWORK AND 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 the furnishing and installation of all pipe hanging and support systems.

#### 1.3 REFERENCES

- A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with the following:
  - 1. ASME - American Society of Mechanical Engineers:
    - a. B31.1 - Power Piping.
    - b. B31.9 - Building Services Piping.
    - c. B31.8 - Gas Transmission and Distribution Piping Systems.
  - 2. MSS - Manufacturers Standardization Society:
    - a. SP-58 - Pipe Hangers and Supports - Materials, Design and Manufacture.
    - b. SP-69 - Pipe Hangers and Supports - Selection and Application - 1996.
    - c. SP-90 - Guidelines on Terminology for Pipe Hangers and Supports.

#### 1.4 DEFINITIONS

- A. Pipe Restraint: Pipe supporting element which is designed to limit or direct pipe movement due to internal static pressure, gravitational forces, frictional forces from hangers, rollers, and guides, and forces from expansion compensation devices:
  - 1. Pipe restraints are not designed to restrain pipe movement caused by thermal expansion, shock or surge.
- B. Pipe Guide: A pipe restraint designed to direct pipe movement along a single axis.
- C. Pipe Anchor: A pipe restraint designed to provide a static point about which pipe movement normally occurs, by limiting the longitudinal and axial movement at that point.
- D. Other Terms: As defined in MSS SP-90.

#### 1.5 DESIGN AND PERFORMANCE REQUIREMENTS

- A. Unless otherwise indicated on Drawings or in these Specifications, this Contractor shall be responsible to design and provide all pipe hangers, supports, restraints, braces, framing, etc., as required to comply with all applicable building codes, ASME B31 and MSS SP-69.
- B. Comply with the requirements of Division 23 Section "Sound and Vibration Control for HVAC" for vibration isolation of piping.
- C. Comply with the requirements of ASME B31.8 for pipe hangers and support of natural gas piping systems.
- D. The Work in this Section includes responsibility for all hangers, supports, restraints, braces, framing, etc. as required to comply with the seismic restraint requirements of the Michigan Building Code of 2015.

## 1.6 SUBMITTALS

- A. Manufacturer's Literature: For structural steel attachment devices, hangers and rollers. Include name of Manufacturer; model number and MSS Type, if applicable; and piping systems to be used with.
- B. Submit Shop Drawings for all engineered hanger, restraints and support assemblies.
  - 1. For Metal Framing Pipe Supports: Include locations, dimensions, lengths, Manufacturer, material, cross-section number or type, finish, pipe sizes, and pipe locations.
- C. Upon request by Engineer, submit calculations for all engineered hanger, restraints and support assemblies.
  - 1. Calculations: For metal framing pipe supports upon request by Engineer. Include support locations, pipe sizes, pipe weights, allowable stresses, and actual stresses.

## 1.7 PERFORMANCE REQUIREMENTS

- A. Design Responsibilities:
  - 1. Anchorage of outdoor piping, ductwork and equipment shall be designed by Contractor or their supplier.
  - 2. Minimum Requirements:
    - a. Details, if any, indicated on the Drawings and Specifications contained herein are minimum requirements.
      - 1) Engineer has designed the structure to withstand the gravity and wind induced loadings of equipment.
      - 2) Notify Engineer of member size change requirements prior to fabrication.
    - b. Generally comply with layouts and configurations as indicated on the Drawings.
  - 3. Structural Performance:
    - a. Design shall be performed by a professional engineer.
    - b. Design shall comply with the building code plus amendments and local ordinances, if any, legally adopted for the location in which the Project is located.
    - c. Design anchorage systems capable of withstanding design loads within limits and under conditions indicated.
      - 1) The term "withstand" means that the unit will remain in place without separation of any parts from the device when subjected to the wind forces specified.
    - d. Design shall include systems that transfer gravity and wind induced loadings (including lateral, overturning and uplift effects) to the structure, including, but not limited to:
      - 1) Anchorage between piping, ductwork or equipment and supports.
      - 2) Anchorage between supports and building structure.
      - 3) Spacers, blocking, straps and the like.
  - 4. Design Loads:
    - a. Dead Loads: Actual weights of materials and fixed equipment, as calculated by designer.
    - b. Wind-Restraint Loading:
      - 1) Basic Wind Speed: 120 mph.
      - 2) Building Classification Category: II.
      - 3) Determined by designer in accordance with the basic parameters indicated on the Drawings and procedures indicated in the Building Code.
      - 4) Design shall not consider shielding by adjacent structures.

## PART 2 - PRODUCTS

### 2.1 GENERAL REQUIREMENTS

- A. The materials of all pipe hanging and supporting elements shall be in accordance with the latest requirements of the ASME Code for Pressure Piping B31.1 and MSS Standard Practice MSS SP-58 and MSS SP-69 except as supplemented or modified by the requirements of these Specifications.
- B. The material in contact with the pipe shall be compatible with the piping material so that neither shall have a deteriorating action on the other.



- C. Special Finishes and Materials:
  - 1. All ferrous hangers and supports used in the following areas shall be hot dip galvanized unless noted otherwise:
    - a. Outside.
    - b. In wet or potentially wet areas.

## 2.2 MANUFACTURERS

- A. Elcon.
- B. Michigan Hanger.
- C. Anvil.
- D. Bergen.
- E. Hilti.
- F. Lindapter.
- G. Thybar
- H. Pate
- I. Mirro
- J. Roof Products and Systems
- K. A.E.S.
- L. MicroMetl.
- M. PHD Manufacturing

## 2.3 PIPE HANGERS AND SUPPORTS

- A. Horizontal Piping Hangers: Unless otherwise indicated and except as specified in piping system Specification sections, install the following types:
  - 1. Adjustable Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30 (DN15 to DN750).
  - 2. Yoke Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 degrees F (49 to 232 degrees C) pipes, NPS 4 to NPS 16 (DN100 to DN400), requiring up to 4 inches (100 mm) of insulation.
  - 3. Carbon or Alloy Steel, Double Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24 (DN20 to DN600), requiring clamp flexibility and up to 4 inches (100 mm) of insulation.
  - 4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24 (DN15 to DN600), if little or no insulation is required.
  - 5. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4 (DN15 to DN100), to allow off-center closure for hanger installation before pipe erection.
  - 6. Adjustable Swivel Split or Solid Ring Hangers (MSS Type 6): For suspension of noninsulated stationary pipes, NPS 3/4 to NPS 8 (DN20 to DN200).
  - 7. Adjustable Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8 (DN 15 to DN200).
  - 8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8 (DN15 to DN200).
  - 9. Adjustable Swivel Ring Band Hangers (MSS Type 10): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 2 (DN15 to DN50).
  - 10. Split Pipe Ring With or Without Turnbuckle Adjustment Hangers (MSS Type 11): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 8 (DN10 to DN200).

11. Extension Hinged or 2 Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 3 (DN10 to DN80).
  12. U-Bolts (MSS Type 24): For support of heavy pipe, NPS 1/2 to NPS 30 (DN15 to DN750).
  13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
- B. Supports and Rollers:
1. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36 (DN100 to DN900), with steel pipe base stanchion support and cast iron floor flange.
  2. Pipe Stanchion Saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 36 (DN100 to DN900), with steel pipe base stanchion support and cast iron floor flange with U-bolt to retain pipe.
  3. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion type support for pipes, NPS 2-1/2 to NPS 36 (DN65 to DN900), if vertical adjustment is required, with steel pipe base stanchion support and cast iron floor flange.
  4. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30 (DN25 to DN750), from 2 rods if longitudinal movement caused by expansion and contraction might occur.
  5. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20 (DN65 to DN500), from single rod if horizontal movement caused by expansion and contraction might occur.
  6. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42 (DN50 to DN1050), if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
  7. Pipe Roll and Plate Units (MSS Type 45): For support of pipes, NPS 2 to NPS 24 (DN50 to DN600), if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
  8. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes, NPS 2 to NPS 30 (DN50 to DN750), if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.
- C. Vertical Piping Clamps: Unless otherwise indicated and except as specified in piping system specification sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20 (DN20 to DN500).
  2. Carbon or Alloy Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20 (DN20 to DN500), if longer ends are required for riser clamps.
- D. Hanger Rod Attachments: Unless otherwise indicated and except as specified in piping system specification sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches (150 mm) for heavy loads.
  2. Steel Clevises (MSS Type 14): For 120 to 450 degree F (49 to 232 degree C) piping installations.
  3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type II, split pipe rings.
  4. Malleable Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
  5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 degree F (49 to 232 degree C) piping installations.
- E. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Specification sections, install the following types:
1. Restraint Control Devices (MSS Type 47): Where indicated to control piping movement.
  2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches (32 mm).
  3. Spring Cushion Roll Hangers (MSS Type 49): For equipping Type 42 roll hanger with springs.
  4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
  5. Variable Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25% to absorb expansion and contraction of piping system from hanger.
  6. Variable Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25% to absorb expansion and contraction of piping system from base support.
  7. Variable Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25% to absorb expansion and contraction of piping system from trapeze support.

8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load adjustment capability. These supports include the following types:
  - a. Horizontal (MSS Type 54): Mounted horizontally.
  - b. Vertical (MSS Type 55): Mounted vertically.
  - c. Trapeze (MSS Type 56): Two vertical type supports and 1 trapeze member.

#### 2.4 HANGER RODS

- A. Minimum rod diameters for rigid rod hangers shall be as shown in MSS SP-69 Table 4 (Minimum Rod Diameter for Single Rigid Rod Hangers) and as indicated in Part 3 of these Specifications.
- B. Hanger rods shall be subject to tensile loading only. At hanger locations where lateral or axial movement is anticipated, suitable linkage shall be provided to permit swing.
- C. Rod material must be compatible with hanger and comply with above. Do not field cut thread on galvanized rod.
- D. Do not use perforated strap.
- E. Multiple Supports:
  1. Horizontal banks of pipe may be supported on a common base member without regard to the pipe centerline elevation.
  2. In the supporting of multiple pipe runs, provisions shall be made to keep the lines in their relative lateral positions, using clamps or clips as required. Lines subject to thermal expansion shall be free to roll axially or slide.

#### 2.5 SADDLES AND SHIELDS

- A. All Piping:
  1. Saddle: MSS Type 39 Anvil Figure 160 -to 165.
  2. Shield: MSS Type 40 (Anvil Figure 167), provide and install in accordance with Manufacturer's shield size selection tables.
  3. The contour of the saddle shall match the radius of the pipe insulation.

#### 2.6 ALIGNMENT GUIDES

- A. Provide at all expansion loops and joints:
  1. As indicated on the Drawings.
  2. As required to maintain alignment.
  3. In accordance with Expansion Joint Manufacturer's Association recommendations.
- B. Pipe Slides and Guides:
  1. Manufacturer:
    - a. Advanced Thermal Systems, Inc.
    - b. As approved by Owner.
  2. Model:
    - a. Figure 101-W for guide weld down applications.
    - b. Figure 101-B for guide bolt down applications.
    - c. Figure 201-W for slide weld down applications.
    - d. Figure 201-B for slide bolt down applications.
  3. Size: Appropriate for pipe size, insulation thickness and length of travel.
  4. Minimum Length of Travel:
    - a. For the first 1/4 of the distance from the anchor to the expansion joint -25% of design travel length of joint.
    - b. For the second 1/4 of the distance from the anchor to the expansion joint -50% of design travel length of joint.

- c. For the third 1/4 of the distance from the anchor to the expansion joint -75% of design travel length of joint.
  - d. For the last 1/4 of the distance from the anchor to the expansion joint - design travel length of joint +25%.
- C. Spider Type Guides:
- 1. Manufacturers:
    - a. Anvil.
    - b. Pentair - ERICO.
    - c. Keflex.
  - 2. Anvil Figure 255, 256; or equal.

## 2.7 FABRICATED STEEL SUPPORTS AND RESTRAINTS

- A. Provide as required:
- 1. Steel shapes and plates.
  - 2. Bolts.
  - 3. Welds.
- B. Materials and fabrication in accordance with:
- 1. AISC Specification for the Design, Fabrication and Erection of Structural Steel for Buildings.
  - 2. AISC Code of Standard Practice for Steel Buildings and Bridges (except Section 4.2.1.).
- C. Design: Responsibility of Subcontractor, except as specifically indicated on Drawings.
- D. Paint all finished fabrications:
- 1. As specified in Division 09 Section "Interior Painting."

## 2.8 MANUFACTURED PIPE SUPPORT SYSTEM

- A. Acceptable Manufacturers:
- 1. Eaton B-Line.
  - 2. Elcen.
  - 3. Super Strut, Inc.
  - 4. Unistrut Building Systems.
- B. Provide products from one Manufacturer.
- C. Channel (Standard Applications):
- 1. Mild strip steel.
  - 2. 12 gage minimum material.
  - 3. Factory painted equal to Unistrut Perma-Green.
  - 4. Equal to Unistrut Part No. P1000.
- D. Stainless Steel Channel and Accessories:
- 1. 304 or 316 stainless steel.
  - 2. 12 gage minimum material.
  - 3. Equal to Unistrut Part No. P1000SS.
  - 4. All clamps, supports and nuts to be similar stainless steel.
- E. Aluminum Channel and Accessories:
- 1. Extruded aluminum.
  - 2. 12 gage minimum material.
  - 3. Equal to Unistrut Part No. P1000EA.
  - 4. All clamps, supports and nuts to be aluminum.

- F. Clamps and Supports:
  - 1. Beam clamp equal to Unistrut Part No. P2785.
  - 2. Pipe strap equal to Unistrut Part No. P2558.
  - 3. Pipe roller equal to Unistrut Part No. P2474.
  - 4. All items fabricated in material equal to channel specifications.
  
- G. Clamp Nuts:
  - 1. Electro-galvanized stainless steel for use with stainless steel and fiberglass parts.
  - 2. Mild bar steel for standard applications.
  - 3. Class 2 American Standard threads.
  - 4. Equal to Unistrut Part No. P1012.

## 2.9 MANUFACTURED EQUIPMENT, DUCTWORK AND PIPING SUPPORT SYSTEM SUBJECT TO WIND OR SEISMIC LOADING

- A. Equipment and Piping Support Rails:
  - 1. General Construction:
    - a. Material: ASTM A653 G90 hot dipped galvanized steel. Minimum 18 gage or heavier, as engineered by Manufacturer.
    - b. Corners: Mitered and welded (welds are micro sealed and prime painted after fabrication). Bolted connections are not accepted.
    - c. Base Plates: Integral to frame and welded.
    - d. Internally reinforced with galvanized 1-inch x 1-inch angles for curbs exceeding 3-foot length.
    - e. Wood Nailers: Factory installed, decay resistant. Size and width as suitable for support of items installed on rail and perimeter of roof deck.
  - 2. Height:
    - a. Minimum 12 inches above finished roof surface. Select support so mechanical equipment air inlets are at least 18 inches above the finished roof surface.
  - 3. Constructed to match roof slope with plumb and level top surface for mounting mechanical equipment.
  - 4. Gasketing: Where required, 1/4-inch thick, 1-inch wide under all units.
  - 5. Counterflashing: 16 gage galvanized steel.
  - 6. Rail assembly shall be installed under metal roof deck. Perimeter steel roof deck shall be supported by rail assembly. Rail bottom flange shall be a minimum width of 2 inches to support roof deck. Steel clips shall be provided where roof deck flutes do not contact bottom flange of rail, to prevent crushing roof deck.
  - 7. Non-canted style.
  
- B. Equipment, Ductwork And Piping Support Frames
  - 1. General Construction:
    - a. Material: Polycarbonate, hot-dipped galvanized steel or stainless steel, as engineered by Manufacturer.
    - b. Frame supports are adjustable, utilizing all thread.
    - c. Frame bases constructed of non-metallic material compatible with roofing material requirements.
    - d. Platforms: Constructed of 18 gage material.
  
- C. Wind and Seismic Restraints: Metal brackets compatible with the piping, ductwork and equipment support and equipment casing, galvanized or painted to match equipment unit, used to anchor unit to the support, and designed for loads at Project site.
  
- D. Building Structural Steel Attachment: Provide wind restraint straps, welded strap connectors, and bolted or welded attachment methods to roof structural steel as required to meet wind uplift requirements.

## 2.10 BUILDING ATTACHMENTS

- A. As indicated on the Drawings or in the Specifications.
  
- B. Concrete Attachments:
  - 1. Provide galvanized finish for all attachments used in wet or potentially wet areas.
  - 2. Provide stainless steel bolts and nuts in wet and potentially wet areas.

3. Poured Concrete:
    - a. Use cast-in-place inserts or bolted surface mounted attachments, at Contractor's option.
    - b. Expansion style anchors are not permitted on piping systems subject to vibration.
  4. Precast Concrete Tees:
    - a. Use fittings specifically designed for attachment to stems of precast tees.
    - b. Drilling is not permitted except where specifically approved by Engineer and coordinated with precast Manufacturer to miss embedded, prestressed steel strands.
  5. Precast Concrete Plank:
    - a. Use toggle bolt attachment as indicated on Drawings.
    - b. Alternatively, provide adhesive anchor, Hilti HY-20; or as approved.
    - c. Drilling is not permitted except where specifically approved by Engineer and coordinated with precast Manufacturer to miss embedded, prestressed steel strands.
- C. Horizontal Piping:
1. Steel W, I, or S shapes: MSS Type 23 clamp with retaining clip, (Anvil Fig. 88 and Fig. 89 for non-seismic and Fig. 89X for seismic applications) up to 2-inch; MSS Type 28 (Anvil Fig. 292) or MSS Type 21 (Anvil Fig. 133, 134) above 2-inch.
  2. Steel Channel: MSS Type 20 universal channel clamp.
  3. Bar Joists: Steel washer plate (Anvil Fig. 60).
  4. Concrete: See "B" above.
  5. Timber: Angle bracket and lag screws or as detailed on Drawings.
  6. Steel Z Shapes: Custom attachment required. Submit details of welded or bolted attachment to Engineer.
- D. Vertical Piping:
1. Steel Shapes: Welded brackets as approved by Engineer.
  2. Concrete: See "B" above.
  3. Timber: Ceiling hanger flange (Anvil Fig. 128R, 153) angle brackets and lag screws, or as indicated on Drawings.
- E. In the absence of a Specification for a particular type of attachment, furnish attachments comparable in type and quality to that specified above for a similar situation.

## PART 3 - EXECUTION

### 3.1 HANGER AND SUPPORT APPLICATIONS

- A. General Requirements:
1. The selection of hangers and supports shall be based on the overall design concept of the system and any special requirements which may be called for in these Specifications or as indicated on the Drawings. The support systems shall provide for, and control, the free or intended movement of the system including its movement in relation to that of the connected equipment. They shall prevent excess stress resulting from the transfer of weight being introduced into the system or connected equipment.
  2. The selection of hangers and supports shall be made to provide the system with the degree of control that its operating characteristics require. Design hangers and supports to prevent sway and intendent movement.
  3. The selection of hangers or supports will take into consideration the combined weight of the supported systems, including system contents.
  4. Select and install hangers and supports to allow controlled thermal and seismic movement of system, to permit freedom of movement between anchors, and facilitate action of expansion joints, expansion loops, expansion bends and similar units.
  5. The spans in MSS SP-69 Table 3 do not apply where concentrated weights, such as valves or heavy fittings, or where changes in direction of the piping occur between hangers.
  6. Select all hangers and supports rated for the maximum potential loading with pipe full.
  7. Select hangers for cold (less than 50 degrees F) piping service for installation over the insulation.

8. Where significant, vertical movement of pipe occurs at the hanger location a resilient support shall be used:
  - a. Selection of resilient supports shall be based on permissible load variations and effects on adjacent equipment. Support selection for typical load variations are shown on MSS SP-69 Table 2 (Spring Support Selection). Load and movement calculations shall be made for the proper selection of spring hangers.
  - b. Vertical movement and load transfer from riser expansion to horizontal runs shall be given consideration when applying spring hangers.
  - c. Spring cushion hangers may be used where vertical movement does not exceed 1/4-inch and where formal load and movement calculations are not required.
  - d. Variable spring hangers shall be used for all other resilient support requirements except as noted in the following paragraph.
  - e. Constant support hangers shall be used on piping systems where the deviation in supporting force must be limited to 6% and which cannot be accommodated by a variable spring hanger.
- B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Specification sections.

### 3.2 HANGER AND SUPPORT INSTALLATION

- A. Pipe Hanger and Support Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. General:
  1. Adjust all components as required for proper operation and required pipe slope.
  2. Double nut all support rods at hangers.
  3. Location and Routing:
    - a. Install Piping as Indicated:
      - 1) On the Drawings.
      - 2) On the reviewed Shop Drawings.
    - b. Secure Engineer's approval for all pipe routing changes.
  4. Coordinate with other trades for placement of concrete attachments prior to concrete pouring.
  5. Install all items in accordance with Manufacturer's instructions.
- C. Support at Valves: Provide additional supports at all valves in piping 4-inch and larger.
- D. Vertical Risers:
  1. Support independently from adjacent hangers on horizontal piping.
  2. Copper Piping:
    - a. Support at the base and at 6-foot maximum centers for sizes 1-1/4-inch and smaller.
    - b. Pipes Larger Than 1-1/4-Inch:
      - 1) Supported at each floor level.
      - 2) Not to exceed 10-foot centers.
  3. Vertical Threaded, Welded or Grooved Steel Piping:
    - a. Support at the base of the riser and at every other floor.
    - b. Maximum allowable unsupported piping length is 12 feet.
  4. Plastic Piping:
    - a. Support at 4-foot centers maximum for sizes 1-1/2-inch or smaller.
    - b. Support at the base and at 4-foot centers for all sizes larger than 1-1/2 inches.
    - c. Completely encircle covering and insulating material.
- E. Horizontal Runs:
  1. General:
    - a. Provide adequate supports for the loads with a factor of safety of at least 5 (400 pounds minimum).
    - b. Provide protective shield at all hangers and rollers supporting plastic pipe and coated pipe.
    - c. Support spacing not to exceed MSS SP-69 Table 3, or the requirements for seismic restraint, whichever is more stringent.
    - d. Hanger rod diameter shall not be less than the requirements of MSS SP-69 Table 4, or the requirements for seismic restraint, whichever is more stringent.

2. Rollers: All piping systems designed to accommodate thermal expansion movement shall be mounted on rollers.
3. Bar Joists: Attachments to bar joists shall be made to top member and at panel points.

F. Ductile Iron Piping: The size of hanger components shall be suitable for the O.D. of the pipe to be supported.

G. Fiberglass Reinforced Pipe (FRP):

1. The size of hanger components shall be suitable for the O.D. of the pipe to be supported.
2. Support spacing shall be based on the Manufacturer's recommendation for the service conditions.
3. FRP should not be point loaded and all shields and hangers in contact with the pipe shall be free of burrs.

### 3.3 PIPE RESTRAINTS

A. Provide adequate pipe restraints for all expansion or contraction of piping due to temperature change:

1. Including, but not limited to, that indicated on the Drawings.
2. As instructed by Owner or Engineer.
3. At locations to prevent stresses from exceeding those permitted by ANSI B31 and to prevent transfer of loading and stresses to connected equipment.
4. Spacing: Unless otherwise indicated, install at ends of main pipe runs, at intermediate joints in pipe runs between expansion loops and bends.

B. Concrete work installed in connection with anchors or supports: Make with approved Portland Cement:

1. At least 5-1/2 bags per cubic yard.
2. Properly mixed with approved aggregate.
3. Attain a compression strength of not less than 3,000 psi at 28 days.

### 3.4 VIBRATION ELIMINATORS

A. Provide as indicated on the Drawings and in accordance with the requirements of Division 23 Section "Sound and Vibration Control for HVAC."

B. Install so as to cause minimum restraint to normal thermal movements.

### 3.5 INSULATION PROTECTION

A. Provide Protection Saddle:

1. Equal to insulation thickness.
2. At each hanger.
3. For all insulated piping systems where longitudinal expansion exceeds 1-inch per 100 feet.

B. Provide insulation protection shield:

1. At each hanger for all "cold" (less than 50 degrees F) piping services.
2. In accordance with the following table:

Pipe Size (IPS)	Shield Gage	Length
5" and Smaller	16	12"
6" to 12"	12	16"
Greater than 12"	12	20"

3. Installed as follows:

- a. Surround lower covering.
- b. Straddle equidistant on hanger.
- c. Flared at both ends as required to avoid damage to pipe covering, jacket and vapor barrier.

### 3.6 PAINTING

A. Touchup: Cleaning and touchup of painting of field welds, bolted connections and abraded areas of shop paint on miscellaneous metal are specified in Division 09 Section "Interior Painting."



- B. Galvanized Surfaces: Clean welds, bolted connections and abraded areas. Apply galvanizing repair paint to comply with ASTM A780.

END OF SECTION 23 05 29

## SECTION 23 05 31 – PENETRATIONS FOR HVAC

### 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 furnishing and installation of the major items listed below:
  - 1. Duct and pipe sleeves.
  - 2. Prefabricated and site built curb assemblies.
  - 3. Flashing and sealing of all mechanical openings through weather or waterproofed walls, roofs and floors.
  - 4. Sealing and finishing of all mechanical openings.
  - 5. Provide UL rated firestopping and sealing at all new and existing pipe penetrations of fire rated walls.
- B. Division of Work: In accordance with the General Conditions, Contractor is responsible for dividing the Work among the Subcontractors and Suppliers and for delineating the work to be performed by specific trades. The following are suggestions as to how the Work may be divided. This is not a complete list of all the work:
  - 1. General Contractor:
    - a. Locate and place all sleeved and framed openings as part of constructing the wall and floor surfaces in which the openings occur.
    - b. Provide all lintels and required stiffening members for wall and floor openings.
    - c. Cut roofing and install flashing for all required openings in proprietary roof membrane systems.
    - d. Cut all roof deck openings and provide required framing supports.
  - 2. Mechanical Subcontractor:
    - a. Advise General Contractor of quantity, location and size of all required openings.
    - b. Provide all curbs, sleeves, seals, escutcheons and related materials required for finishing, sealing and waterproofing mechanical openings. Furnish all flashing and counterflashing.
    - c. Arrange and pay for all openings required after wall, roof and floor construction is complete.

#### 1.3 REFERENCES

- A. Except as herein specified or as indicated on the Drawings, the Work of this Section shall comply with ASTM D2202 - Test Method for Slump of Sealants.

#### 1.4 SUBMITTALS

- A. Manufacturer's Literature: For all premanufactured curbs and sealing assemblies.
  - 1. Manufacturer's name.
  - 2. Model number.
  - 3. Details of construction and installation.
  - 4. Certified load-bearing data for all curbs.
- B. Delegated-Design Submittal
  - 1. Structural calculations for anchorage systems, sealed by the Professional Engineer responsible for the design.
  - 2. Clearly indicating design criteria and loadings used.
  - 3. For each vibration isolation and seismic-restraint device.
    - a. Include design calculations and details for selecting vibration isolators and seismic restraints complying with performance requirements, design criteria, and analysis data signed and sealed by the qualified Professional Engineer responsible for their preparation.

## 1.5 PERFORMANCE REQUIREMENTS

- A. Design Responsibilities:
1. Anchorage of outdoor equipment shall be designed by Contractor.
  2. Minimum Requirements:
    - a. Details, if any, indicated on the Drawings and Specifications contained herein are minimum requirements.
      - 1) Engineer has designed the structure to withstand the gravity and wind induced loadings of equipment.
      - 2) Notify Engineer of member size change requirements prior to fabrication.
    - b. Generally comply with layouts and configurations as indicated on the Drawings.
  3. Structural Performance:
    - a. Design shall be performed by a professional engineer.
    - b. Design shall comply with the building code plus amendments and local ordinances, if any, legally adopted for the location in which the Project is located.
    - c. Design anchorage systems capable of withstanding design loads within limits and under conditions indicated.
      - 1) The term "withstand" means that the unit will remain in place without separation of any parts from the device when subjected to the wind forces specified.
    - d. Design shall include systems that transfer gravity and wind induced loadings (including lateral, overturning and uplift effects) to the structure, including, but not limited to:
      - 1) Anchorage between units and curbs.
      - 2) Anchorage between curbs and building structure.
      - 3) Spacers, blocking, straps and the like.
  4. Design Loads:
    - a. Dead Loads: Actual weights of materials and fixed equipment, as calculated by designer.
    - b. Wind-Restraint Loading:
      - 1) Basic Wind Speed: 120 mph.
      - 2) Building Classification Category: III.
      - 3) Determined by designer in accordance with the basic parameters indicated on the Drawings and procedures indicated in the Building Code.
      - 4) Design shall not consider shielding by adjacent structures.

## 1.6 QUALITY ASSURANCE

- A. Fabrication and Installation Personnel Qualifications:
1. Trained and experienced in the fabrication and installation of the materials and equipment.
  2. Knowledgeable of the design and the reviewed submittals.
- B. Codes and Standards: "Architectural Sheet Metal Manual" as published by SMACNA.
- C. Openings in Fire-Rated Surfaces: As specified in Division 07 Section "Firestopping."
- D. Delegated Designer Qualifications:
1. Professional Engineer licensed in the state in which the Project is located.
  2. Having experience in a minimum of 5 projects in the last 10 years of comparable or greater complexity

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Curbs:
1. The Pate Company.
  2. Roof Products and Systems Corporation.
  3. Thycurb Corporation.
  4. A.E.S.
  5. MicroMetl.

- B. Pipe Seals and Boots:
  - 1. The Pate Company.
  - 2. Portals Plus, Inc.
  - 3. Roof Products and Systems Corporation.
  - 4. Thunderline Corporation.
  - 5. Thycurb Corporation.
- C. Modular Mechanical Seals:
  - 1. Thunderline/Link-Seal.
  - 2. As approved.
- D. Backer Rod: Industrial Thermo Polymers, "Standard Backer Rod".
- E. Acoustical Sealant: Pecora, "BA-98".
- F. Non-Expanding Sealant: General Electric SilPruf SCS2000:
  - 1. VOC content must be 250 g/liter or less.

## 2.2 MATERIALS

- A. Backer Rod:
  - 1. Extruded round, closed cell, polyethylene foam.
  - 2. Resilient, non-exuding.
  - 3. Density: 2.0 pounds per cubic foot.
  - 4. Tensile Strength: 50 psi.
  - 5. Nonabsorbent to water and gasoline.
  - 6. Suitable for use as a backing for acoustical sealant.
  - 7. Compatible with sealant and approved by sealant Manufacturer.
- B. Acoustical Sealant: Nonfire-Rated Penetrations:
  - 1. Non-drying, non-hardening and non-bleeding.
  - 2. Laboratory tested sealant which effectively reduces airborne sound transmission through wall systems.
  - 3. Viscosity: 350,000 to 400,000 (Brookfield No. 65, 10 RPM).
  - 4. Aging: Firm but rubbery, good tack after 50 days conditioned at 160 degrees F.
  - 5. Slump: 0.1 to 0.2 inches in accordance with ASTM D2202.
  - 6. Color: Gray.
- C. Packing Material for Penetrations:
  - 1. Glass Fiber or Mineral Fiber:
    - a. Noncombustible.
    - b. Resistant to water, mildew, and vermin.
  - 2. Expanding Resilient Foams:
    - a. Acceptable alternative if manufactured for this purpose.
    - b. Minimum material density: 60 pounds per cubic foot.
  - 3. Fire-Rated Penetrations: Permanently flexible, approved firestop putty. Refer to Division 07 Section "Firestopping."

## 2.3 SLEEVES

- A. Materials:
  - 1. 18-Gage Galvanized Steel:
    - a. For ductwork openings.
    - b. For pipe penetrations in non-bearing walls.
  - 2. Schedule 40 Steel Pipe:
    - a. For all bearing walls.
    - b. For all floors.
    - c. For all concrete or masonry walls.
  - 3. Cast Iron Pipe: For all exterior below grade installations.

- B. Size All Sleeves:
  - 1. To allow for movement due to expansion, without contact to pipe or insulation.
  - 2. To provide for continuous insulation, except as required by Division 07 Section "Firestopping."
  - 3. As indicated on the Drawings.

## 2.4 MANUFACTURED UNITS

- A. Structural Roof Curbs:
  - 1. Frames:
    - a. Material: ASTM A653 G90 hot dipped galvanized steel. Minimum 18 gage or heavier, as engineered by Manufacturer.
    - b. Corners: Mitered and welded (welds are micro sealed and prime painted after fabrication). Bolted connections are not accepted.
    - c. Base Plates: Integral to frame and welded.
    - d. Internally reinforced with galvanized 1-inch x 1-inch angles for curbs exceeding 3-foot length. Reinforce internal bulkhead at equipment curbs to support lateral loads.
    - e. Wood Nailers: Factory installed, decay resistant. Size and width as suitable for support of items installed on curbs and perimeter of roof deck.
  - 2. Curb Height:
    - a. Minimum 12 inches above finished roof surface. Select roof curb so mechanical equipment air inlets are at least 18 inches above the finished roof surface.
    - b. Select curb height so that grease duct flange/top of curb is at least 18 inches above finished roof surface with base set on roof structure under the roof decking.
  - 3. Construct curbs to match roof slope with plumb and level top surface for mounting mechanical equipment.
  - 4. Gasketing: 1/4-inch thick, 1-inch wide under all units.
  - 5. Counterflashing: 16 gage galvanized steel.
  - 6. Insulation: Minimum 1-1/2-inch, 3-pound density fiberglass insulation.
  - 7. Curb assembly shall be installed under metal roof deck. Perimeter steel roof deck shall be supported by structural curb assembly. Structural curb bottom flange shall be a minimum width of 2 inches to support roof deck. Steel clips shall be provided where roof deck flutes do not contact bottom flange of structural curb, to prevent crushing roof deck.
  - 8. Non-canted style.
  - 9. Curbs for fans and similar mechanical equipment items are furnished by equipment Supplier unless specified otherwise.
- B. Wind and Seismic Restraints: Metal brackets compatible with the curb and casing, painted to match RTU, used to anchor unit to the curb, and designed for loads at Project site.
- C. Wind Restraint Straps and Base Flange Attachment: Provide wind restraint straps, welded strap connectors, and base flange attachment to roof structure at perimeter of curb, of size and spacing required to meet wind uplift requirements.
- D. Exterior Wall or Roof Pipe Opening Seals:
  - 1. Compatible with installation conditions.
  - 2. Equal to One of the Following:
    - a. Pate "Pipe Seal".
    - b. Pate "Pipe Curb Assembly".
  - 3. Link-Seal.
- E. Modular Mechanical Seals:
  - 1. Provide modular, mechanical type, consisting of inter-locking synthetic rubber links shaped to continuously fill the annular space between the pipe and the wall opening.
  - 2. The elastomeric element shall be sized and selected in accordance with Manufacturer's recommendations and have the following properties as designated by ASTM:
    - a. For Standard Service Applications:
      - 1) -40 to +250 degrees F (-40 to +121 degrees C).
      - 2) EPDM = ASTM D2000 M3 BA510.

- b. For High Temperature or Fire Seal Applications:
  - 1) -67 to +400 degrees F (-55 to +204 degrees C).
  - 2) Silicone = ASTM D2000 M1GE505.

### PART 3 - EXECUTION

#### 3.1 ROOF OPENINGS

- A. Ducts:
  - 1. Pass through prefabricated curbs.
  - 2. Curb Counterflashing:
    - a. Solder or pop-rivet with mastic to the duct and extended over and down the top of the curbs for a minimum distance of 2 inches.
    - b. Secure to the sides of the wood strips with corrosion-protected lag screws and washers 12 inches on center.
- B. Piping:
  - 1. As indicated on the Drawings.
  - 2. For Multiple Pipes Through Single Opening:
    - a. Select sleeve or opening seals of ample size to accommodate pipes.
  - 3. Fill Annulus Opening:
    - a. Use non-combustible insulation material.
    - b. Full depth of sleeve.
  - 4. Provide Moisture Protection Using Premanufactured:
    - a. Elastomeric boot.
    - b. Metal hood.
    - c. Flashing fitting.
- C. Locate curbs and sleeves a minimum of 12 inches from walls to permit proper flashing.

#### 3.2 INTERIOR WALL AND FLOOR OPENINGS

- A. Flash all floor-mounted drains except in slabs on grade:
  - 1. Use integral flashing flange and clamp.
  - 2. As specified in Division 22 Section "Plumbing Piping and Specialties."
- B. Use riser sleeve with integral flashing flange and clamp for all waterproof membrane floors.
- C. Seal airtight all openings around pipes and ducts in the structure at:
  - 1. Mechanical equipment rooms.
  - 2. Noise-critical spaces indicated in specifications and on the Drawings. Refer to Division 23 Section "Sound and Vibration Control for HVAC."
  - 3. Slab and noise sensitive wall penetrations indicated on the Architectural Drawings.
  - 4. Penetrations of all drywall ceilings and concrete slabs suspended on isolators.
  - 5. All enclosed shaft penetrations.
- D. Duct Penetrations:
  - 1. Where each duct passes through a wall, floor, or ceiling, there shall be a clear annular space of 1-inch (25 mm) between the duct and structure.
  - 2. Frame, sleeve, or grout all voids in opening perimeter to contain packing material.
  - 3. After all of the ductwork is installed, check the clearance, and pack the voids full depth with packing material. In noise-critical walls and floors, calk both ends with acoustical sealant backed by a backer rod or permanently flexible firestop material.
  - 4. Where there is not sufficient access space to pack around all sides of a duct (for example, at the underside of a slab), first place a short stub duct in the wall, pack and calk around it, and then attach the inlet and outlet ducts to each end.

5. Where ducts enter or leave a shaft or pass through a wall or slab in sufficient numbers and density that individual pack-and-calk details are not possible, special isolation details shall be developed:
  - a. Before the shaft is fully enclosed, seal the penetration with a heavy membrane surrounding the ducts on each side of the wall or slab being penetrated.
  - b. Each membrane may be 2 layers drywall, 1-inch (25 mm) plaster or 14-gage lead sheet.
  - c. Other materials may be acceptable.
  - d. Pack the void between the 2 membranes with packing material or pump full of resilient closed cell firestop foam.
  - e. Calk all edges airtight.
  - f. In all cases, the proposed detail shall be approved by Engineer.

E. Pipe Penetrations:

1. HVAC Piping:

- a. Where a pipe passes through a wall, ceiling, or floor, place cast or grout a sleeve into the structure.
- b. Internal diameter of the sleeve: 2 inches (50 mm) larger than the external diameter of the bare pipe or pipe insulation O.D. passing through it.
- c. After all of the piping is installed in a specific area, check the clearance and correct it, if necessary, to within 1/2-inch (12 mm).
- d. Pack the void full depth with packing material and seal at both ends, with minimum 1-inch (25 mm) deep sealant.
- e. In noise-critical walls and floors, pack with acoustical sealant backed by foam rod.
- f. Where pipes pass through a masonry wall in sufficient numbers and density that individual pack-and-calk details are not possible, a special isolation detail shall be developed:
  - 1) Cast pipe sleeves in a block of concrete with the sleeves located a minimum of 2 inches (50 mm) apart.
  - 2) Block thickness: At least as thick as the surrounding wall construction.
  - 3) Each sleeve diameter: 2 inches (50 mm) larger than the external diameter of the pipe passing through it.
  - 4) Build the sleeved block into the wall.
  - 5) After the pipes are installed, pack and calk voids as indicated above.

2. Compressed Air Pipes:

- a. May be sleeved and sealed as indicated above, or (except where crossing an acoustic joint) may be grouted and calked into the structure as follows:
  - 1) Before grout has set, rake a 1/2-inch deep (12 mm by 12 mm) groove around the pipe on each side of the wall or slab.
  - 2) After the grout has set, fill groove full depth with sealant.
- b. Penetration of sound isolating ceilings (concrete or multi-layer drywall) by fire protection pipes and heads shall be sleeved and sealed as indicated herein. There shall be no rigid connection between ceiling and pipes or heads.

### 3.3 OUTSIDE WALL OPENINGS

A. Ducts:

1. Pass through openings provided by Contractor.
2. Size opening to allow approximately 1-inch clearance at all duct or duct covering surfaces.
3. Provide sheet metal closures, insulation, calking, flashing and drip edges.
4. Install to ensure 100% weatherproof construction.

B. Pipes:

1. Pass through sleeves fabricated of Schedule 40 pipe cut 3/8-inch back from face of wall on each side.
2. Sealed 100% watertight.
3. Pipes below grade use cast iron sleeves.

### 3.4 FLOOR SLEEVES IN POTENTIALLY WET AREAS

- A. All floors except slabs on grade.
- B. Extend sleeves 3 inches above finished floor.
- C. Provide poured concrete curb for duct openings as indicated in the Drawings.

3.5 ESCUTCHEONS AND CLOSURE COLLARS

- A. Includes penetrations of ceilings, partitions, floor, and walls.
  
- B. Provide Escutcheons for All Piping Exposed to View:
  - 1. As indicated on the Drawings.
  - 2. Sized to fit over coverings.
  - 3. In All Dry Finished Areas: Chrome plated.
  - 4. Do not use escutcheons in acoustic isolation walls unless otherwise indicated.
  
- C. Provide Sheet Metal Closure Collar for all Ductwork:
  - 1. Fit snugly around duct or covering, and surface penetrated without contact.
  - 2. Attach with approved fasteners 6-inch centers maximum spacing.
  - 3. Fabricate with minimum 4-inch face.

END OF SECTION 23 05 31



## SECTION 23 05 46 – SOUND AND VIBRATION CONTROL FOR HVAC

### 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 furnishing and installation of all equipment for and related items incidental to isolation and attenuation of mechanical vibration and sound:
  - 1. Major Items:
    - a. Isolate mechanical rotating or vibrating equipment with vibration isolators.
    - b. Connect ductwork and piping to equipment by means of flexible connections.
    - c. Install mechanical equipment, piping and ductwork on, or suspended from, approved and specified foundations or supports.
    - d. Install internal acoustical duct lining as indicated on Drawings or specified herein.
    - e. Install duct silencers and plenums as indicated on Drawings or specified herein.
  - 2. All vibration isolation devices shall be furnished by a single Manufacturer.
- B. Division of Work: In accordance with the General Conditions, Contractor is responsible for dividing the Work among the Subcontractors and Suppliers and for delineating the work to be performed by specific trades. The following are suggestions as to how the Work may be divided. This is not a complete list of all the work:
  - 1. General Contractor: Provide concrete equipment pads.
  - 2. Mechanical Subcontractor:
    - a. Provide miscellaneous structural steel necessary for support of mechanical work.
    - b. Coordinate necessary alterations in structural steel.

#### 1.3 REFERENCES

- A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with the following:
  - 1. ASC - Adhesive and Sealant Council: A-7001C - Adhesives for Duct Liner.
  - 2. ASHRAE - 2015 Handbook - Table 47 of Chapter 48 - "Selection Guide for Vibration Isolation".
  - 3. ASTM:
    - a. C423 - Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
    - b. C665 - Specification for Mineral Fiber Blanket Thermal Insulation.
    - c. C916 - Specification for Adhesives for Duct Thermal Insulation.
    - d. C1071 - Specification for Thermal and Acoustical Insulation (Glass Fiber, Duct Lining Material).
    - e. E84 - Test Method for Surface Burning Characteristics of Building Materials.
    - f. E90 - Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions.
    - g. E477 - Test Method for Measuring Acoustical and Air Flow Performance of Duct Liner Materials and Prefabricated Silencers.
    - h. G21 - Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
    - i. G22 - Practice for Determining Resistance of Plastics to Bacteria.
  - 4. NAIMA - North American Insulation Manufacturers Association: Fibrous Glass Duct Liner Standard.
  - 5. NFPA Standard:
    - a. 90A - Installation of Air Conditioning and Ventilating Systems.
    - b. 255 - Surface Burning Characteristics of Building Materials.
  - 6. SMACNA: HVAC Duct Construction Standards - Metal and Flexible.
  - 7. UL: 181 - Factory-Made Air Ducts and Air Connectors.

#### 1.4 DESIGN AND PERFORMANCE REQUIREMENTS

- A. The isolation materials Manufacturer shall be responsible for the proper selection of isolators to achieve the specified minimum static deflections, for all isolators, based on the actual weight distribution of equipment to be isolated.
- B. The isolation materials Manufacturer shall be responsible for the structural design of steel beam bases and concrete inertia bases, to support mechanical equipment scheduled to receive such supplementary bases.
- C. Be responsible for verifying the completeness of the isolation installation and the overall suitability of the equipment to meet the intent of this Specification. All additional equipment needed to meet the intent of this Specification, even if not specifically mentioned herein or in the Contract Documents, shall be supplied by the Contractor without claim for additional payment.
- D. Sealing of Penetrations: Designated building structures designed to isolate air-borne noise surrounding all critical and noisy spaces. Proper routing of and sealing or lagging (enclosure), or both, around mechanical services penetrating these structures are necessary to maintain the integrity of the isolating structure.
- E. Structural Isolation: Separations of building structures along acoustical joints have been designed to reduce structure-borne transmission of sound into critical spaces. Mechanical and electrical services must avoid rigid bridging across two structures isolated from each other.

#### 1.5 NOISE CRITICAL SPACES

- A. Noise-critical walls are walls separating the office from the plant area, and include spaces that contain noise producing equipment in addition to the "noise-critical" spaces listed above. Noise-critical slabs are those slabs (and all associated isolated ceilings or floating floor slabs) that are above and below rooms enclosed by noise critical walls.
- B. Penetrations of noise critical walls and slabs by ducts, pipes, and conduit shall be sleeved, packed, and sealed airtight with non-hardening sealant as described in Division 23 Section "Penetrations for HVAC."

#### 1.6 SUBMITTALS

- A. Manufacturer's Literature: For all products described under Part 2 of these Specifications.
  - 1. General:
    - a. Dimensions.
    - b. Construction details.
    - c. Manufacturer's name.
    - d. Model number.
  - 2. Spring Isolators:
    - a. Rated deflection.
    - b. Spring constant.
    - c. Model number.
    - d. Type of isolator.
    - e. Size.
    - f. Height when uncompressed and maximum allowed static deflection.
    - g. Isolator location shown on an outline of the isolated equipment.
    - h. Detail drawings of inertia bases isolators.
    - i. Location of isolators on plan drawings of the isolated area, where applicable.
    - j. The weight of all isolated equipment, and the loads on each isolator and the static deflection of each isolator under the specific design load shall be listed along with the proposed isolators.
    - k. Pipe isolators shall be shown and identified on piping layout Drawings.
  - 3. Acoustical Plenums, Silencers, and Duct Lining:
    - a. Certified acoustical performance through octave bands from 63 Hz to 8000 Hz.
    - b. Air pressure drop.

4. Silencers:
  - a. Submit test data from an independent laboratory showing the insertion loss and airflow-regenerated noise of the specified silencers in octave bands from 63 Hz to 8000 Hz, measured according to the duct to room method ASTM E477, or in duct intensity method. Pressure drop ratings shall be measured for the same silencer tested for acoustical performance, and the data shall be submitted with the acoustical performance data. The insertion loss of the silencers shall be measured with octave band or 1/3 octave band pink noise.
  - b. Over extrapolation and data from out-dated equipment are unacceptable.
- B. Furnish a complete set of approved Shop Drawings of all mechanical and electrical equipment to receive vibration isolation devices to the vibration isolation materials Manufacturer, based upon the selection of vibration isolators and design of supplementary bases will be completed. The Shop Drawings to be furnished shall include operating weights of the equipment to be isolated and the distribution of weight at support points.

#### 1.7 QUALITY ASSURANCE

- A. Fabrication and Installation Personnel Qualifications:
  1. Trained and experienced in the fabrication and installation of the materials and equipment.
  2. Knowledgeable of the design and the reviewed Shop Drawings.
- B. Manufacturer or Qualified Representative Services:
  1. Provide necessary field supervision.
  2. Ensure correct installation and adjustment.
- C. Regulatory Agencies Requirements:
  1. Comply with all state and local codes and ordinances.
  2. Insulation, facing, and adhesive shall have a composite rating:
    - a. 25 flame spread maximum.
    - b. 50 smoke developed maximum.
    - c. In accordance with NFPA 255.
  3. Installation of acoustic duct liner shall be in accordance with:
    - a. SMACNA - HVAC Duct Construction Standards - Metal and Flexible:
      - 1) Acoustical Liner Installation Standards.
      - 2) Mechanical Fastener Standard.
    - b. NAIMA - Fibrous Glass Duct Liner Standards.

#### 1.8 DELIVERY, STORAGE, AND HANDLING

- A. All materials shall be delivered in original, unbroken, brand marked containers or wrapping as applicable.
- B. Handle and store materials in a manner which will prevent deterioration or damage, contamination with foreign matter, damage by weather or elements, and in accordance with Manufacturer's directions.
- C. Reject damaged, deteriorated, or contaminated material and immediately remove from the Site. Replace rejected materials with new materials at no additional cost to Owner.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Flexible Duct Connectors:
  1. Ventfabrics; "Ventglas and Ventsil".
  2. Duro Dyne; "Neoprene".

- B. Vibration Control: All vibration control apparatus shall be provided by a single Manufacturer except as specifically noted herein:
  - 1. Amber-Booth.
  - 2. Mason Industries, Inc.
  - 3. Vibron.
  - 4. Kinetics.
  
- C. Acoustic Duct Liner:
  - 1. Johns Manville; "Permacote Linacoustic Standard duct Liner".
  - 2. Certainteed "Toughgard" with Enhanced Surface".
  - 3. Equivalent by Knauf.
  - 4. Round Ductwork: Johns Manville; "Permacote Spiracoustic Plus Preformed Round Liner".
  
- D. Acoustic Duct Liner Adhesives:
  - 1. Foster Products.
  - 2. Childers.
  - 3. Baldwin-Ehret-Hill.
  - 4. Armstrong.
  - 5. Goodloe E. Moore.
  - 6. Precision Adhesive, Inc.
  - 7. Mon-Eco Industries, Inc.
  - 8. Johns Manville.
  
- E. Mass Barrier: Kinetics Noise control; "KNM-100AL".
  
- F. Duct Silencers:
  - 1. Industrial Acoustics.
  - 2. Koppers.
  - 3. United Sheet Metal.
  - 4. Gale.
  - 5. Aerosonics.
  - 6. Vibro-Acoustics.
  
- G. Acoustic Turning Vanes: Airsan Corporation; "Acoustiturn".
  
- H. Transfer Silencers:
  - 1. Aerosonics.
  - 2. Industrial Acoustic Company.
  
- I. Sound Isolation Extended Base:
  - 1. Greenheck; "ATE".
  - 2. Pate.
  - 3. Cook.
  
- J. Acoustic Rooftop Unit Insulation: United States Gypsum Company.
  
- K. Vibration Isolation Curbs:
  - 1. Pate.
  - 2. Kinetics.
  - 3. Mason.

## 2.2 MATERIALS

- A. Acoustic Duct Liner:
  - 1. Thermosetting resin bonded mat of dual density glass fiber coated on airstream side with an immobilized EPA registered anti-microbial agent.
  - 2. Density: 1.9 pounds/cubic foot.
  - 3. Thickness: 1-inch.
  - 4. Thermal Conductance (c): 0.24 at 75 degrees F mean temperature.

5. Acoustical Performance:

Minimum Sound Absorption Coefficients at Octave Band Center Frequencies (Hz)						
125	250	500	1,000	2,000	4,000	NRC
0.09	0.29	0.67	0.89	1.03	0.99	0.70

6. Facing:

- a. Factory-applied black acrylic coating.
- b. Fire-Resistant:
  - 1) Comply with NFPA 90A.
  - 2) UL listed.
  - 3) 25 flame spread and 50 smoke developed rating.
- c. Rated for velocities at 5000 fpm tested in accordance with UL 181 without wearing of the surface or entrainment of glass fibers into air stream.
- d. Designed to minimize friction loss.
- e. The insulation must be resistant to microbial growth as determined by:
  - 1) UL 181: Mold Growth and Humidity Test.
  - 2) ASTM C1071: Fungi Resistance Test.
  - 3) ASTM G21: Synthetic Material fungi Resistance Test.
  - 4) ASTM G22: Synthetic Material Bacteria Resistance Test.

7. Use Johns Manville "Permacote Superseal" for edge coating and in areas requiring repair.

B. Round Acoustic Duct Liner:

1. Thermosetting resin bonded mat of dual density glass fiber coated on airstream side with an immobilized EPA registered antimicrobial agent.
2. Density: 1.9 pounds/cubic foot.
3. Thickness: 1-inch.
4. Thermal Conductance (C): 0.24 at 75 degrees F mean temperature.
5. Acoustical Performance:

Inside Diameter (in.)	Sound Attenuation dB/ft 1/3 Octave Band						
	Frequency: Cycles per Second						
	125	250	500	1,000	2,000	4,000	8,000
8	0.4	1.3	3.3	6.1	7.1	4.8	2.2
12	0.3	0.8	2.2	5.1	5.7	2.0	1.3
16	0.2	0.6	1.7	4.2	2.8	1.5	1.3
20	0.1	0.6	1.9	4.1	1.5	1.1	1.1
24	0.0	0.3	1.3	2.6	1.3	1.0	0.9

6. Facing:

- a. Factory-applied black acrylic coating.
- b. Fire-Resistant:
  - 1) Comply with NFPA 90A.
  - 2) UL listed.
  - 3) 25 flame spread and 50 smoke developed rating.
- c. Rated for velocities at 5000 fpm testing in accordance with UL 181 without wearing of the surface or entrainment of glass fibers into air stream.
- d. Designed to minimize friction loss.
- e. The insulation must be resistant to microbial growth as determined by:
  - 1) UL 181 - Mold Growth and Humidity Test.
  - 2) ASTM C1071 - Fungi Resistance Test.
  - 3) ASTM G21 - Synthetic Material Fungi Resistance Test.
  - 4) ASTM G22 - Synthetic Material Bacteria Resistance Test.

7. Use Johns Manville "Permacote SuperSeal" for edge coating and areas requiring repair as required.

- C. Duct Liner Fasteners:
  - 1. Mechanically Secured:
    - a. 12-gage galvanized steel.
    - b. Impact-driven into duct.
    - c. Form positive mechanical attachment to sheet metal.
    - d. Fastener shall not compress the insulation more than 1/8-inch.
  - 2. Weld-Secured:
    - a. Attached to Duct by:
      - 1) Resistance welding.
      - 2) Capacitance discharge welding.
    - b. Fastener Head:
      - 1) 0.075 square inch minimum area.
      - 2) 0.01-inch minimum thickness.
      - 3) Cupped or beveled.
      - 4) Shall not compress the insulation more than 1/8-inch.
  
- D. Acoustic Duct Liner Adhesives:
  - 1. As recommended by Manufacturer of insulation.
  - 2. Solvent or water-based.
  - 3. Fire-resistant: 25 flame spread and 50 smoke developed rating.
  - 4. Comply with ASTM C916.
  - 5. Manufacturers:
    - a. Foster 85-60 / 85-20.
    - b. Childers CP-127 / CP-82.
    - c. Duro-Dyne SSG.
  
- E. Mass Barrier:
  - 1. Loaded, limp vinyl with fire-resistant reinforced foil facing.
  - 2. Density: 1.0 pounds square foot.
  - 3. Thickness: 0.1-inch.
  - 4. Thermal Conductivity (k): 0.29 at 75 degrees F mean.
  - 5. Sound Transmission Loss (STC): 27 dB minimum with 15 dB minimum in the first 3 bands.
  - 6. Facing: Reinforced aluminum foil complying with NFPA 90A for 25/50.

### 2.3 VIBRATION ISOLATION EQUIPMENT

- A. Flexible Duct Connectors:
  - 1. Flexible sleeves for duct connections shall be fabricated from flexible, airtight, coated fabric. Each sleeve shall be installed with at least 3 inches (75 mm) slack across a clear metal to metal gap of at least 4 inches (100 mm). That is, 7 inches (175 mm) of this fabric is required for each sleeve.
  - 2. Standard Temperature Type:
    - a. Glass fabric, double coated with polychloroprene.
    - b. Coated Fabric Weight: 30 ounces per square yard.
    - c. Thickness: 0.024 inches.
    - d. Temperature Range: -20 to 200 degrees F.
    - e. Tensile Strength:
      - 1) 480 pounds per inch warp.
      - 2) 360 pounds per inch fill.
    - f. Abrasion Resistance: 600 cycles.
  - 3. High Temperature Type:
    - a. Glass fabric, silicone coated.
    - b. Coated Fabric Weight: 16 ounces per square yard.
    - c. Thickness: 0.017 inches.
    - d. Temperature Range: -25 to 500 degrees F.
    - e. Tensile Strength:
      - 1) 285 pounds per inch warp.
      - 2) 185 pounds per inch fill.
    - f. Abrasion Resistance: 600 cycles.

- B. Vibration Isolation Curb:
1. Isolation assembly shall consist of extruded aluminum upper and lower members incorporating cadmium plated steel springs with 1-inch static deflection and insuring uniform deflection for the entire system.
  2. Spring diameter shall be equal to or greater than the loaded spring height and shall be equal to 50% of the rated deflection.
  3. A continuous flexible waterproof seal shall be riveted to both upper and lower members. Assembly shall include both upper and lower gasket material.
- C. Isolation Pads:
1. Isolator Type WP:
    - a. Type WP (waffle pads) shall be 5/16-inch (8 mm) thick neoprene pads, ribbed or waffled on both sides. The pads shall be selected for 15% strain. Where required, steel load-spreading plates shall be incorporated between the equipment and the neoprene pad. Neoprene shall be bridge-bearing quality with a maximum durometer (Shore A scale) of 50.
    - b. If the isolator is bolted to the structure, a neoprene vibration isolation washer and sleeve (Uniroyal Type 620/660 or as approved) shall be installed under the bolt head between the steel washer and the base plate.
    - c. Type WP: Mason Industries Type W; or as approved by Engineer.
  2. Isolator Type MWP:
    - a. Type MWP (metal and waffle sandwich pads) shall consist of two 5/16-inch (8 mm) thick ribbed or waffle neoprene pads sandwiching a 16 gage stainless or galvanized steel shim plate. The pad shall be designed for 15% strain. Neoprene shall be bridge-bearing quality with a maximum durometer (Shore A scale) of 50.
    - b. If the isolator is bolted to the structure, a neoprene vibration isolation washer and sleeve (Uniroyal Type 620/660, or as approved) shall be installed under the bolt head between the steel washer and the base plate.
    - c. Type MWP: Mason Industries Type WSW; or as approved by Engineer.
  3. Isolator Type DDNM:
    - a. Type DDNM (double deflection neoprene mounts) shall be laterally stable, double deflecting, molded neoprene isolators. All metal surfaces shall be covered with neoprene. The top and bottom surfaces shall be ribbed and bolt holes shall be provided in the base. The mounts shall have leveling bolts rigidly secured to the equipment.
    - b. The strain on the neoprene shall not exceed 15%. DDNM mounts shall be selected for a static deflection of 3/8-inch (9 mm) unless otherwise specified. Neoprene shall be bridge-bearing quality with a maximum durometer (Shore A scale) of 50.
    - c. Type DDNM: Mason Industries Type ND; or as approved by Engineer.
  4. Isolator Type RBA:
    - a. Type RBA isolators shall be designed with a neoprene element to provide isolation in tension, shear or compression. Neoprene shall be bridge-bearing quality with a maximum durometer of 50.
    - b. Type RBA: Mason Industries Type RBA; or as approved by Engineer.
- D. Isolation Hangers:
1. Isolator Type DDNH:
    - a. Type DDNH (double deflection neoprene hangers) shall consist of a molded neoprene isolating element in a steel hanger box. A neoprene grommet extending from and continuous with the main neoprene element shall be provided where the lower hanger rod passes through the steel hanger box, such that the hanger rod cannot contact the steel hanger. The diameter of the clear hole in the hanger box shall be at least 3/4-inch (19 mm) larger than the diameter of the hanger rod and permit the hanger rod to swing through a 30-degree arc. When installed, the hanger box shall be allowed to rotate through a full 360 degrees without encountering any obstructions.
    - b. Unless otherwise specified, the static deflection of DDNH hangers shall be 0.3 inches (8 mm) with a strain not exceeding 15%. Neoprene shall be bridge-bearing quality with a maximum durometer (Shore A scale) of 50.
    - c. Type DDNH: Mason Industries Type HD; or as approved by Engineer.

- E. Spring Isolators:
1. Isolator Type SPNM:
    - a. Type SPNM (spring and neoprene mounts) shall have a free-standing and laterally stable steel spring without any housing. Springs shall be designed so that the ratio of the horizontal to vertical spring constant is between 1 and 2. The spring diameter shall be not less than 80% of the compressed height of the spring at rated load. Loaded springs shall have a minimum additional travel to solid equal to 50% of the specified static deflection. Unless otherwise specified, the minimum static deflection of SPNM isolators for equipment mounted on grade slabs shall be 1-inch (25 mm), and the minimum static deflection for equipment mounted above the lowest level (i.e., not on a grade slab) shall be 2 inches (50 mm).
    - b. Two Type WP isolation pads sandwiching a 16 gage stainless or galvanized steel separator plate shall be bonded to the isolator baseplate.
    - c. Unless otherwise specified, isolators need not be bolted to the floor for indoor installations. If the base plates are bolted to the structure, a neoprene vibration isolation washer and sleeve (Uniroyal Type 620/660; or as approved) shall be installed under the bolt head between the steel washer and the base plate.
    - d. Type SPNM: Mason Industries Type SLFSW; or as approved by Engineer.
  2. Isolator Type SPNH:
    - a. Type SPNH (spring and neoprene hangers) shall consist of a steel spring in series with a neoprene isolating element. The spring shall have a minimum additional travel to solid equal to 50% of the specified deflection. The neoprene element shall have a static deflection of not less than 0.3 inches (8 mm) with a strain not exceeding 15%.
    - b. Unless otherwise specified, the static deflection of SPNH hangers shall be 2 inches (50 mm). Neoprene shall be bridge-bearing quality with a maximum durometer of 50.
    - c. Spring diameter and hanger box hole size shall be large enough to permit the hanger rod to swing through a 30 degree arc. A neoprene grommet extending from and contiguous with the main neoprene element shall be provided where the hanger rod passes through the steel hanger box, such that the hanger rod cannot contact the steel hanger box. The diameter of the clear hole in the hanger box shall be at least 3/4-inch (19 mm) larger than the diameter of the hanger rod. When installed, the spring element shall not be cocked, and the hanger box shall be allowed to rotate through a full 360 degree arc without encountering any obstructions.
    - d. Type SPNH: Mason Industries Type 30N; or as approved by Engineer.
  3. Isolator Type CSNM:
    - a. Type CSNM (constrained spring and neoprene mounts) shall be a spring and neoprene mount that incorporates a housing which includes vertical limit stops to prevent spring expansion when weight (water or other fluid) is removed from the equipment and limits the movement of equipment when it is subjected to wind loading. A minimum clearance of 1-inch (25 mm) shall be maintained around restraining bolts and between the housing and the spring, so as not to interfere with the spring operation. Limit stops shall be out of contact during normal operation, backed away from contact by at least 1/2-inch (12 mm); a neoprene washer shall be installed beneath the bolt head/washer used to restrain the isolator. In outdoor rooftop installations isolators must be bolted to the roof or supporting structure with a neoprene mounting sleeve.
    - b. Unless otherwise specified, the minimum static deflection for Type CSNM mounts shall be 2 inches (50 mm).
    - c. Type CSNM: Mason Industries Type SLR; or as pre-approved by Engineer.
- F. Neoprene Mounting Sleeves: Neoprene mounting sleeves for hold-down applications of equipment with vibration isolators shall be Uniroyal Type 620/660.
- G. Pipe Flexible Connectors:
  1. Isolator type PFC (pipe flexible connectors) shall be Kevlar-reinforced neoprene, single or double-sphere design. Flexible connectors with control rods will not be permitted.
  2. Type PFC: Mason Industries "Safelex" Type SFEJ or SFDEJ.
- H. Riser Guide for Isolated Pipework: Riser guides for isolated pipes shall be type DDNM isolators bolted to the vertical edge of a 90 degree steel angle. The guide shall allow the pipe to move axially, but shall limit lateral movement to approximately 1-inch (25 mm).



2.4 SOUND CONTROL EQUIPMENT

A. Duct Silencers:

1. Rectangular duct silencers shall have outer casings of not less than 22 gage galvanized steel. Seams shall be lock-formed and mastic filled. The internal baffles (splitters) shall be not less than 24 gage galvanized perforated steel having an open area of 25% to 40%.
2. The nosings shall be full radius or airfoil shape. The sound absorbing media shall be not less than 4.5 pounds/cubic feet (75 kg/cubic meter) glass/mineral fiber packed under 5% compression. The fiber fill shall be incombustible, mildew-resistant, and vermin-proof. The sound absorbing material shall be protected from erosion.
3. If the silencer is supplied in modular sections, the silencer shall meet or exceed the specification for single-module silencers with respect to insertion loss, pressure drop, regenerated noise and air leakage.
4. Silencer rating shall be determined in a duct to reverberate room test facility which provides for air flow through the silencers during ratings. The test set-up and procedure shall be such that all effects due to end reflection directivity, flanking transmission, standing waves and test chamber sound adsorption are eliminated. Acoustic rating shall include Dynamic Insertion Loss and Self Noise Power Levels both at 2000 fpm face velocity.

B. Acoustic Turning Vanes:

1. Construction:
  - a. Double wall made of 1-1/2 pound density fiberglass rated for 4,000 fpm.
  - b. Minimum 24 gage galvanized steel side rails and perforated inner face.
  - c. Minimum 14 gage aluminum outer wall.
  - d. Reinforce turning vanes in ducts over 24 inches by rods or sectional construction to limit unsupported length to 24 inches.
2. Use "Acoustiturn" model with adjustable vanes and split rails at elbows where the duct size changes.

C. Transfer Silencers:

1. Construction:
  - a. Outer Casing: 22 gage galvanized sheet metal.
  - b. Interior Partitions: Packed with inert, vermin-and-moisture-proof mineral or glass fiber.
  - c. Baffles: 24 gage perforated galvanized sheet metal.
2. Acoustical Fill Fire Ratings:
  - a. Flame Spread: 0.
  - b. Fuel Contributed: 20.
  - c. Smoke Developed: 0.
  - d. Tested in accordance with ASTM E84.
3. Acoustical Performance:
  - a. Performance shall not be less than:

Noise Reduction in Decibels Center Frequency (Hertz)							
63	125	250	500	1,000	2,000	4,000	8,000
22	30	33	37	47	49	49	43

D. Sound Isolation Extended Base:

1. Construction:
  - a. Galvanized steel construction.
  - b. Continuous mitered and welded corner seams.
  - c. Base compatible with roof curb.
  - d. 1-1/2-inch thick, 6 pounds per cubic foot density rigid glass fiber insulation around interior curb wall.
  - e. Baffle:
    - 1) Aluminum die formed sections.
    - 2) Fiberglass wool fill.
    - 3) Spring steel wire holding clips to allow baffle removal.
  - f. Performance: 50% reduction of sound level.

## PART 3 - EXECUTION

### 3.1 GENERAL

- A. Unless otherwise indicated, all equipment mounted on vibration isolators shall have a minimum operating clearance of 2 inches (50 mm) between the bottom of the equipment or inertia base (and height-saving bracket) and the concrete housekeeping pad (or bolt heads, whichever is closest) beneath the equipment. The clearance shall be checked to ensure that no scraps have been left to short-circuit the vibration isolators. There shall be a minimum 4-inch (100 mm) clearance between isolated equipment and the walls, ceiling, floors, columns, and any other equipment not installed on vibration isolators.
- B. Piping, ductwork, conduit or mechanical equipment shall not be hung from or supported on other equipment, pipes, or ductwork installed on vibration isolators. It shall be supported on or suspended from building structure.
- C. Equipment connected to fluid piping shall be erected on isolators or isolated foundations at correct operating heights prior to connection of piping. Equipment should be blocked-up with temporary shims to final operating height. When the system is assembled and fluid is added, the isolators shall be adjusted to allow removal of the shims, and confirm that the isolators for the fluid-filled pipes, pumps, and other elements deflect the specified amounts and no more.
- D. All mechanical equipment not specifically identified in this Specification that contains rotating or vibrating elements, and all associated electrical apparatus installed by this division that contains transformers or inductors shall be installed on Type DDNM or RBA neoprene isolators as appropriate. In all such instances, submit the proposed isolators with the isolator Shop Drawings.
- E. All isolators that are to be installed outdoors or exposed to the weather shall be hot-dipped galvanized and shall be furnished with neoprene mounting sleeves for hold-down bolts to prevent any metal-to-metal contact.
- F. Elastomeric isolators that will be exposed to temperatures below 32 degrees F (0 degrees C), shall be fabricated from natural rubber instead of neoprene.
- G. Wiring:
  - 1. All wiring connections to mechanical equipment on vibration isolators (either spring or neoprene type) shall be made with a minimum 36-inch (1 m) long flexible conduit in a 360-degree loop.
  - 2. All ties used to form the loop shall be removed prior to adjusting the isolators.

### 3.2 FAN ISOLATION

- A. General:
  - 1. Fans in air handlers shall be mounted on vibration isolators as described herein.
  - 2. Fans in air handling units shall be leveled with the fans operating before the flexible connectors are attached.
  - 3. All fan bases and isolators shall be sized so that thrust restraints (which would act against turning moment caused by static pressure) are not required.
  - 4. Fan plenums, air mixing plenums, and package air handler plenums shall be installed on a 4-inch (100 mm) high reinforced concrete housekeeping pad, and with a continuous Type WP neoprene isolator at the entire perimeter of the base.
- B. Roof-Mounted Equipment:
  - 1. Roof-mounted condensing units, packaged air-conditioning units, and fans shall be installed on rooftop isolation curbs using Type CSNM isolators.
  - 2. All hardware must be plated or galvanized to provide a rust-resistant finish. Weather-proofing shall be provided by a continuous flexible seal.
  - 3. All springs shall have removable waterproof covers to allow for adjustment or replacement of the springs.

### 3.3 PIPE ISOLATION

- A. Pipes Connected to Equipment on Spring Isolators:
  - 1. All pipes connected to equipment installed on spring vibration isolators shall be suspended, supported, and guided for at least 30 feet by means of appropriate spring vibration isolators as described below. This includes, but is not necessarily limited to heating pipes. Pipes shall be supported by Type SPNM isolators or hung from the structure on Type SPNH isolators.
  - 2. The first isolator both upstream and downstream of equipment on springs shall have a static deflection equal to 1.5 times that of the equipment isolators, up to a maximum of 2 inches (50 mm). The static deflection of the remaining pipe isolators shall be 1-inch (25 mm).
- B. Pipes Connected to Equipment on Neoprene Isolators: Piping in the that is connected only to machinery installed on neoprene isolators shall be either supported from the floor on Type DDNM mounts or suspended from the structure on Type DDNH hangers.
- C. Pipes With Multiple Connections: Where a pipe run connects multiple items of equipment in the mechanical room, the pipe isolators for the entire run shall be chosen to suit the connected equipment of greatest static deflection.
- D. A flexible connector shall be installed to connect a pipe on isolators to a piece of equipment on isolators of less static deflection than the pipe.

### 3.4 SHEET METAL DUCTWORK

- A. Duct Isolation:
  - 1. All ducts shall be supported on either Type DDNM or Type DDNH isolators for a minimum of 5 times the maximum duct dimension after the rooftop unit.
  - 2. Where a duct crosses an acoustic joint in the structure, the duct shall be supported on neoprene hangers or mounts for a minimum of 5 times the outside duct height on each side of the joint.
  - 3. Ducts shall be connected to fans, fan casings, and fan plenums by means of flexible connectors. Flexible duct connectors shall not be used outside the mechanical room in systems serving noise-critical spaces unless expressly indicated on the Drawings.
- B. Duct Silencers:
  - 1. Duct silencers shall be furnished and installed as indicated on the Drawings and as called for in the silencer schedule.
  - 2. The governing parameters for silencer selection are insertion loss, pressure drop, and self-noise; these data shall appear for each silencer on the Project. The Manufacturer shall demonstrate how the data was measured and derived; over-extrapolation is unacceptable.
  - 3. The clear inner dimensions of the duct silencer shall match the clear inner dimensions of the ductwork to which it is attached.
- C. Ductwork Fabrication: Fabricate ductwork so as to be free from vibration, rattle, or drumming under all operating conditions; provide all materials necessary for specified construction, whether or not they are specifically called for or detailed on the Drawings.
- D. Bracing of Ductwork: Do not install tie rods inside ducts.
- E. Ductwork Wall Penetrations: Seal around ductwork wall penetrations as specified in Division 23 Section "Penetrations for HVAC."

### 3.5 ACOUSTIC LINING OF DUCTS

- A. Application:
  - 1. Ductwork, except where noted otherwise, to be lined:
    - a. All ductwork used exclusively to transfer air connected to one room to another.
    - b. Where indicated on the Drawings.

2. Ductwork Not to be Lined:
  - a. Buried ductwork.
  - b. Outside air intakes.
  - c. Relief air ductwork.
  - d. Exhaust ductwork.
  - e. All ductwork conveying or potentially conveying unfiltered or untempered outside air or mixed air.
- B. Thickness:
  1. Lining shall be 1-inch (25 mm) thick in all internally lined sheet metal ducts, unless otherwise specified or indicated on the Drawings.
  2. Where internal lining is also specified in Division 23 Section "Duct Insulation" for thermal duct lining, the greater thickness shall be used.
- C. Where round ductwork is to be internally lined, a double wall duct system with perforated inner wall as specified in Division 23 Section "Metal Ducts" may be used.
- D. Installation:
  1. The acoustic liner shall be fixed to the duct with a minimum of 50% coverage of a fire-resistant adhesive. All perimeter acoustic liner edges shall be coated with adhesive.
  2. Where the duct width exceeds 12 inches (300 mm) or a height of 24 inches (600 mm), the liner shall be additionally secured with mechanical fastening on maximum 16-inch (400 mm) centers, and no more than 3 inches from ductwork edges or insulation joints.
  3. Mechanical fasteners that pierce the duct are unacceptable.
  4. All portions of duct specified to receive acoustic liner shall be completely covered.
    - a. Transverse joints shall be neatly butted and there shall be no interruption or gaps.
    - b. All transverse edges are to be 100% covered with Manufacturer-supplied edge coating.
    - c. Cut liner to ensure tight corner joints.
    - d. All corner joints are to be either lapped and butted, or folded.
    - e. Black coated surface is to face air stream.
  5. Acoustic liner shall be 100% covered with Manufacturer supplied coating at all exposed surfaces, edges, and transverse joints. Metal nosing shall be used at seams and joints as indicated on Drawings.
  6. Where acoustic duct lining is installed, the dimensions of the sheet metal shall be increased to include the thickness of the lining material. Dimensions indicated on the Drawings are the net clear internal dimensions after the acoustic liner has been installed.
  7. Exposed and leading edges will be covered with metal nosing around the entire perimeter.
  8. Round acoustic liner shall be slid into round metal ducts in accordance with Manufacturer's instructions.

### 3.6 LINING OF ACOUSTICAL PLENUMS

- A. Unless otherwise specified, acoustical plenums shall be lined with 4-inch (100 mm) glass/mineral fiber duct liner.
- B. Acoustical plenums shall be constructed with prefabricated plenum panels (which contain the lining), concrete, masonry, or other architectural material as indicated on the Drawings.
- C. Two layers of 2-inch (50 mm) lining is acceptable as an alternative to a single layer of 4-inch lining.

### 3.7 MISCELLANEOUS EQUIPMENT

- A. Flexible Duct Connectors:
  1. Install at duct connections to air moving equipment.
  2. Install at locations indicated on Drawings.
- B. Acoustic Turning Vanes:
  1. Use in all rectangular mitered elbows with R/D ratio of less than 1.5, and elsewhere as indicated.
  2. Install evenly spaced along elbow diagonal with leading and trailing edges aligned to sides of duct.
  3. Install vanes on 3-3/4-inch centers.
  4. Elbows Where Duct Changes Size: Use Airsan Corporation "Acoustiturn" with adjustable vanes and split rails. Align leading and trailing edges to be parallel to duct sides.

- C. Mass Barrier: Wrap all duct drops from rooftop units and roof exhaust fans and all duct connected to the drops within 5 feet.
- D. Transfer Silencers:
  - 1. Install at all locations as indicated on Drawings.
  - 2. Seal around transfer silencer wall penetrations as specified in Division 23 Section "Penetrations for HVAC."
- E. Acoustic Rooftop Unit Isolation: Install at all packaged rooftop units.

### 3.8 FIELD QUALITY

- A. Work in accord with best trade practices, fabricate and install all items in accordance with Manufacturer's recommendations and Engineer's directions, and consult with trades doing adjoining work in order to provide an installation of first class quality.

### 3.9 ADJUSTMENT AND TESTING

- A. Site Access: During installation of equipment, arrange for access as necessary for inspection of isolation and noise control equipment by Engineer.
- B. Inspection:
  - 1. Upon completing installation and adjustment for suitable operation of all work specified under this Section, notify Engineer in writing, who will schedule a review.
  - 2. The Contractor's letter shall certify that all work specified under this Section is complete, operational, and adjusted in every respect, and that all work under this Section is ready for the completion checkout.
  - 3. The notification letter shall be accompanied by a copy of the air balancing report.
  - 4. For each inspection, workmen shall be furnished to perform such functions as are necessary for inspection of the equipment.
  - 5. Measurement of background noise levels by the Engineer requires that there be a minimum of extraneous noise.
  - 6. Such measurements must be scheduled during late-night hours when there is no work taking place on the Site.
  - 7. Workmen shall be employed during the testing procedure to turn on and off all mechanical and electrical equipment for such background noise level testing.

END OF SECTION 23 05 46

## SECTION 23 05 73 – TESTING AND CLEANING OF HVAC 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. This Section includes providing testing and cleaning services and the major items listed below:
  - 1. Arrange and pay for all costs of utilities and chemicals required for the Work.
  - 2. Repair and Restore All Work Damaged:
    - a. By tests.
    - b. By cutting required in connection with the tests.

#### 1.3 REFERENCES

- A. American National Standards Institute/Institute of Inspection Cleaning and Restoration Certification (ANSI/IICRC).
  - 1. ANSI/IICRC S520 - Standard for Professional Mold Remediation.
- B. National Air Duct Cleaners Association (NADCA):
  - 1. ACR – Standard for Assessment, Cleaning & Restoration of HVAC Systems (Current Version).
- C. National Fire Protection Association (NFPA) Standards:
  - 1. 90A - Installation of Air-Conditioning and Ventilating Systems.
  - 2. 90B - Installation of Warm Air Heating and Air-Conditioning Systems.
- D. North American Insulation Manufacturers Association (NAIMA):
  - 1. Cleaning Fibrous Glass Insulated Air Duct Systems.
- E. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):
  - 1. HVAC Duct Construction Standards - Metal and Flexible.
- F. Underwriters' Laboratories (UL) Standards:
  - 1. 181 - UL Standard for Safety Factory-Made Air Ducts and Connectors.
  - 2. 181A - UL Standard for Safety Closure Systems for Use with Rigid Air Ducts.
- G. US Green Building Council (USGBC).

#### 1.4 SUBMITTALS

- A. Flushing and Cleaning:
  - 1. Submit certificates for all code-required inspections.
  - 2. Submit all duct cleaning chemicals to be used.
- B. Pressure Test Reports:
  - 1. Submit within 1 week after each system pressure test.
  - 2. List time, date and persons present for the following for each system:
    - a. Initial tests.
    - b. Final test.
  - 3. Include report indicating:
    - a. Test type and duration.
    - b. Initial pressure.
    - c. Final pressure.
  - 4. Indicate that necessary repairs and final tests were satisfactorily completed.

- C. Duct Cleaning Submittals:
  - 1. Record Documentation: Submit documentation verifying compliance with this specification for work performed. This documentation may include:
    - a. Photo images, HVAC plans and other supporting documents such as submittal forms for materials used and/or warranties or guarantees.
    - b. System areas found to be damaged or in need of repair.

#### 1.5 QUALITY ASSURANCE

- A. Comply with all applicable codes.
- B. Secure State Health Department approval for potable water systems.
- C. Testing and Cleaning Agency:
  - 1. Provide regional laboratory support services.
  - 2. HVAC System Cleaning Contractor: Current member of NADCA experienced in HVAC cleaning projects of similar size and complexity.

### PART 2 - PRODUCTS

#### 2.1 CLEANING AGENT MANUFACTURERS

- A. Aqua-Chem.
- B. Aquatrol.
- C. Enerco.
- D. Nalco.

#### 2.2 MATERIALS

- A. Detergents, solvents, and other cleaning agents shall be compatible with materials of fabrication of systems where they are used. No cleaning agent shall adversely affect materials or mechanisms in systems and cleaning agents shall be acceptable to equipment manufacturers and the Owner's environmental coordinator.
- B. Detergents, solvents, and other cleaning agents shall be compatible with process streams to be handled by systems in which the cleaning agents are used.
- C. Owner will provide water for cleaning and flushing. Other cleaning fluids, agents, and equipment shall be provided by Contractor.
- D. Provide all necessary temporary equipment required for cleaning and flushing operations.
- E. Duct Cleaning:
  - 1. Antimicrobial Agents: Type recommended by Certified Industrial Hygienist (CIH), determined from biological contamination test results.

### PART 3 - EXECUTION

#### 3.1 DUCT AND AIR HANDLING EQUIPMENT CLEANING

- A. Perform HVAC system cleaning in accordance with ACR, The NADCA Standard.

- B. Access:
1. Access duct cleaning work through existing or new service openings, allowing safe access and thorough cleaning throughout specified components.
  2. Where new service openings are required, install openings as follows:
    - a. Do not degrade structural, thermal, or functional system integrity, and comply with applicable SMACNA duct construction methods.
    - b. Where required, install closure panels fabricated from equivalent material and same or heavier gage.
    - c. Mechanically fasten closure panels over service openings with screws or rivets at perimeter.
    - d. Fabricate closure panel to overlap duct opening perimeter, minimum 1-inch.
    - e. Insulate closure panels to match adjacent duct interior and exterior surfaces.
    - f. Mark outside of duct and report service opening locations to Owner in project closeout documents.
- C. General:
1. Clean HVAC components employing agitation device to dislodge contaminants from HVAC component surface, and then capturing contaminants with vacuum collection device.
    - a. Acceptable methods include those that do not damage integrity of ductwork and other system components, and does not damage porous surface materials including internal insulation and duct lining.
  2. Clean HVAC components using source removal mechanical cleaning methods designed to extract contaminants from within HVAC system and safely remove contaminants from facility.
  3. Select source removal methods rendering HVAC system visibly clean and capable of passing cleanliness verification methods as described in ACR, The NADCA Standard.
  4. Do not employ cleaning method, or combination of methods, that can damage HVAC system components or negatively alter system integrity.
  5. Do not damage HVAC system and components with wet cleaning, power washing, steam cleaning and other wet process cleaning.
  6. Apply cleaning materials in accordance with Manufacturer's instructions.
    - a. Do not apply cleaning agents or water to electrical, fibrous glass or other porous HVAC system components.
  7. Verify HVAC system surface and component cleanliness in accordance NADCA Standard.
  8. Particulate Collection:
    - a. Employ contaminant removal methods incorporating vacuum collection devices operated continuously during cleaning.
      - 1) Connect vacuum collection device to component being cleaned through service opening.
      - 2) Employ vacuum collection device of sufficient capacity to maintain areas being cleaned under negative pressure, containing debris is contained and preventing contaminant migration to adjacent areas.
    - b. When possible, discharge ducted exhaust air from vacuum collection devices outdoors, keeping discharge air clear of outdoor air intakes, operable windows, and other locations allowing outdoor air entry.
      - 1) Do not violate outdoor environmental standards, codes or regulations.
      - 2) Do not discharge unfiltered air from vacuum collection devices outdoors.
      - 3) When necessary to exhaust vacuum collection devices indoors, including hand-held and wet-vacuum machines, keep discharge air in work area, and provide machine air discharge HEPA filtration, rated at 99.97 percent collection efficiency for 0.3 micron particles and larger.
- D. Cleaning Methods:
1. Type 1 Dry Cleaning Method:
    - a. Operate HEPA-filtered negative air machines that discharge continuously during Type 1 cleaning process.
    - b. Mechanically remove adhered dirt and contaminants in accordance with ACR, The NADCA Standard.
  2. Type 2 Wet Cleaning Method:
    - a. Employ Type 2 wet cleaning method when visual inspection reveals suspect microbial matter on coil or drain pan. Access both upstream and downstream sides of each coil section for cleaning.
    - b. Employ engineering controls required for coil cleaning in accordance with ACR, The NADCA Standard.
    - c. Verify cleanliness after cleaning has been performed as described in ACR, The NADCA Standard.



- d. Perform Type 2 cleaning if debris still remains on the coil or the coil is impacted after Type 1 cleaning has been completed and post-cleaning inspection has been performed.
  - e. After cleaning, verify cleanliness of HVAC coils in accordance ACR, The NADCA Standard.
  - f. Retain the following paragraph and subparagraph when the work includes duct-mounted, inline coil cleaning. Otherwise, delete.
- E. Air Handling Unit (AHU) Cleaning:
1. Clean blowers, fan housings, ducted plenums, scrolls, blades, or vanes, shafts, baffles, dampers and drive assemblies.
  2. Remove visible non-adhered particulate deposits in accordance with ACR, The NADCA Standard.
  3. Clean air handling unit (AHU) internal surfaces, components and condensate pans, and drains.
  4. Clean heat transfer coils, fans, condensate pans, drains and similar non-porous surfaces in conjunction with mechanical methods as described in ACR, The NADCA Standard.
  5. Control water spray and extraction are sufficient to collect debris and prevent water damage to HVAC components and surrounding equipment.
  6. Capture, contain, test and dispose of waste water generated while performing wet cleaning in accordance with applicable federal, state, and local regulations, and requirements of Authorities Having Jurisdiction.
  7. After cleaning, verify HVAC system surface and component cleanliness in accordance ACR, The NADCA Standard.
- F. Air Duct Systems:
1. Clean air ducts to remove non-adhered substances.
  2. Access air duct interiors through service openings in system that are large enough to accommodate mechanical cleaning procedures and allow for cleanliness verification.
  3. Use mechanical agitation methods to remove particulate, debris, and non-adhered particulate.
  4. Capture dislodged substances with vacuum collection device.
  5. Do not employ cleaning methods that damage HVAC components.
  6. Mark position of dampers and air-directional mechanical devices inside HVAC system prior to cleaning.
  7. When cleaning is complete, restore dampers and devices to their marked positions.
  8. After cleaning, verify cleanliness of HVAC system surfaces and components in accordance ACR, The NADCA Standard.
- G. AHU Coils:
1. Perform visual coil and drain pan inspection to determine whether Type 1 dry cleaning or Type 2 wet cleaning is required.
  2. Employ cleaning methods rendering coil visibly clean in accordance with ACR, The NADCA Standard.
  3. Isolate coil from duct system during cleaning process. Do not allow removed particles to migrate to, or redeposit on, unintended areas.
  4. Apply coil cleaning products in accordance with manufacturer's published data and labeling.
  5. Clean and flush condensate drain pan and drain line. Verify proper drainage operation before and after cleaning.
  6. Apply cleaning methods and products that do not cause damage to, or erosion of, coil surface or fins.
- H. Electric Resistance Coils:
1. De-energize, lock out, and tag out power source to coil.
  2. Employ Type 1 dry cleaning methods.
  3. Employ cleaning methods which will render coil visibly clean in accordance with ACR, The NADCA Standard.
  4. Isolate coil from duct system during cleaning process. Do not allow removed particles to migrate to, or redeposit on, unintended areas.
  5. Apply coil cleaning products in accordance with manufacturer's published data and labeling.
  6. Apply cleaning methods and products that do not cause damage to, or erosion of, coil surface or fins.
- I. Internally Insulated Duct System Components and Sound Attenuators:
1. Employ cleaning methods that do not damage internal insulation or sound attenuating components, and that render system capable of passing cleanliness verification tests.
  2. Clean fibrous glass duct liner or duct board present in equipment or air ducts employing mechanical agitation methods to remove particulate, debris, and non-adhered particulate.
  3. Do not create abrasions, breaks, or tears to fibrous glass liner or duct board surfaces.

4. Maintain HVAC system under constant negative pressure when cleaning internal insulation components.
  5. Do not wet insulation components.
  6. Identify for replacement fibrous glass materials with evidence of damage, deterioration, delaminating, friable materials, biological growth, or moisture that cannot be restored by cleaning or resurfacing.
  7. When required, remediate exposed, damaged insulation exposed to HVAC system air stream.
  8. Scrape insulation and adhesive residue from metal duct system surfaces that have undergone degraded insulation removal.
  9. Remove loose, visible debris prior to installation of new insulation.
  10. Retain the following paragraph if mold-contaminated duct liner was removed. Otherwise, delete.
  11. Where biologically contaminated insulation was removed, apply antimicrobial agents to remove traces of contamination or abate mold in accordance with ANSI/IICRC S520.
  12. When replacement insulation installation is complete, verify that new fibrous glass surfaces are capable of compliance with NADCA cleanliness verification requirements.
- J. Special Techniques:
1. Controlling Product Emissions:
    - a. Apply cleaning agents and other chemicals in accordance with manufacturer's recommended procedures and product application instructions, including exhaust ventilation.
  2. Negative Duct Pressurization:
    - a. Throughout cleaning process, keep HVAC system and associated air ducts at negative differential pressure, relative to indoor non-work area.
    - b. Maintain negative pressure differential between portion of HVAC duct system being cleaned and surrounding indoor occupant spaces.
    - c. Continuously monitor and verify correct pressure differential.
    - d. When performing vacuum collection, employ negative air machine drawing air from equipment being cleaned.
    - e. When negative air machine is not fitted with HEPA filtration, duct exhaust air from negative air machine to outdoor location, keeping discharge air clear of outdoor air intakes, operable windows, and other locations where outdoor air enters building.
    - f. Do not discharge unfiltered air from vacuum collection devices outdoors.
  3. Microbial Agents:
    - a. Apply antimicrobial agents only when active biological growth is reasonably suspected, or where unacceptable levels of biological contamination have been verified through testing.
    - b. Apply antimicrobial agents after removal of surface deposits and debris.
    - c. Apply antimicrobial agents in accordance with antimicrobial agent manufacturer's written recommendations and associated EPA registration listing.
- K. Field Quality Control:
1. Inspect work to verify cleanliness immediately after HVAC system component cleaning and prior to placing system in operation.
  2. Do not apply treatment, coating, or antimicrobial agent to cleaned HVAC system or components until the work has been inspected and determined to be acceptable.
  3. Visual Inspection:
    - a. When cleaning is complete, perform final inspection in presence of Owner.
    - b. Perform visual inspection of porous and non-porous HVAC system component surfaces. Verify HVAC system is visibly clean as defined in ACR, The NADCA Standard.
    - c. If no contaminants are evident through visual inspection, HVAC is considered clean and acceptable.
    - d. If contaminants are evident through visual inspection, repeat cleaning system areas where contaminants are visible.
    - e. Notify Owner to schedule cleanliness re-inspection.
  4. Surface Comparison Test for Porous Surfaces Only:
    - a. If visual inspection is inconclusive or disputed, then perform Surface Comparison Test in accordance with ACR, The NADCA Standard.
    - b. Attach vacuum brush to operating contact vacuum.
    - c. Employ contact vacuum with HEPA-filtered discharge, capable of achieving minimum 80 inches w.g. static lift and fitted with 2.5-inch diameter round nylon brush attached to 1.5-inch diameter vacuum hose.
    - d. Pass brush over surface test area 4 times.

- e. Visually compare tested and untested surfaces to determine whether visible surface characteristics are detectable.
- f. When surface comparison test is complete, HVAC component surface is considered acceptably clean if there is no visually detectable difference between tested and untested surface characteristics.

### 3.2 CLEANING AND FINISHING

- A. Comply with the requirements of Division 01 Section "Cleaning and Waste Management."
- B. After tests have been made and the system pronounced tight:
  1. Clean piping and equipment.
  2. Lubricate bearings.
- C. Final cleaning includes but is not limited to the following:
  1. Equipment with Factory Finishes:
    - a. Wash factory-finished equipment with mild soap and water and leave in first-class condition, entirely free of stains or streaks.
    - b. Do not use abrasive materials.
    - c. Touch up scratches or other violations of the factory finish paint with matching paint from the equipment Manufacturer.
- D. Disposal Of Job Site Duct Cleaning Waste:
  1. Seal HVAC system debris and removed contaminated materials in containers before removal from work area.
  2. Handle materials classified as hazardous by governmental agencies in accordance with applicable federal, state, and local regulations and codes.

END OF SECTION 23 05 73

SECTION 23 05 93 – TESTING, ADJUSTING AND BALANCING FOR HVAC

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 description of the mechanical system testing, adjusting and balancing (TAB) scope of services. The following systems shall be included in the testing, adjusting, and balancing process:
1. Electric heating systems.
  2. Air handling/air distribution systems.
  3. Exhaust systems.
  4. Variable frequency drives.
  5. Domestic hot water recirculation systems.
  6. Thermal storage.
  7. Kitchen Heating, Ventilation and Air Conditioning:
    - a. Exhaust systems.
    - b. Cooking equipment.
    - c. Walk-in coolers.
- B. Division of Work:
1. In accordance with the General Conditions, Contractor shall be responsible for dividing the Work among the Subcontractors and Suppliers and for delineating the work to be performed by specific trades.
  2. The following are suggestions as to how the Work may be divided. This is not a complete list of all the work:
    - a. Mechanical Subcontractor:
      - 1) Provide related work as specified herein to support the mechanical systems TAB work being performed by TAB engineer.
      - 2) Provide access to all balancing devices.
      - 3) Provide replacement fan sheaves and impellers:
        - a) At no additional cost to Owner.
        - b) As required to achieve design performance for mechanical equipment.
      - 4) Perform system start-up functions including, but not necessarily limited to:
        - a) Venting air from all hydronic system piping and components.
        - b) Setting all manually operated dampers and valves in the full open position.
        - c) Complete and submit pre-test and balance checklist to Engineer and TAB engineer prior to start of TAB work.
      - 5) Correct all mechanical system deficiencies identified by TAB engineer.
    - b. TAB Engineer:
      - 1) Provide timely notice to mechanical Subcontractor, TCS Subcontractor and Commissioning Authority of all incomplete work and deficiencies which prevent proper performance of test and balance work.
      - 2) Test, adjust and balance all air and hydronic systems and prepare final report.
    - c. Temperature Control System (TCS) Subcontractor:
      - 1) Provide related work as specified herein to support the mechanical systems TAB work being performed by TAB engineer.
      - 2) Operate all temperature control devices to support TAB work that is dependent on various control operating modes.
      - 3) Correct all TCS system deficiencies identified by TAB engineer.
    - d. Commissioning Authority: Provide verification of system function in conformance with design intent, including systems balance and adjustment, and controls function.

### 1.3 REFERENCES

- A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with the following:
  - 1. Sheet Metal and Air Conditioning Contractor's Association (SMACNA) publications:
    - a. Procedural Standards for Testing, Adjusting, and Balancing of environmental systems.
    - b. Procedural Standards for Measuring Sound of Vibration.
    - c. Testing, Adjusting, Balancing Manual for Technicians.
  - 2. Associated Air Balance Council (AABC): National Standards for Total System Balance, 2002 Edition.
  - 3. National Environmental Balancing Bureau (NEBB): Procedural standards for testing, adjusting, and balancing of environmental systems.
  - 4. Testing, Adjusting, and Balancing Bureau (TABB): TAB Procedural Guide.

### 1.4 DEFINITIONS

- A. Proper Performance Characteristics:
  - 1. In accordance with design intent, acceptable energy efficiency and Manufacturer's recommendations.
  - 2. Providing acceptable thermal and acoustical performance in all service areas.
  - 3. As directed by Engineer.
- B. TAB Engineer: An individual, firm or corporation whose primary work is testing, adjusting and balancing environmental systems working.

### 1.5 SUBMITTALS

- A. Submit Pre-Test and Balance Checklist and mechanical systems TAB report in accordance with Division 01 Section "Submittal Procedures."
- B. Submit Pre-Test and Balance Checklist at least 2 weeks prior to scheduled start of TAB work as scheduled by Contractor and approved by Owner.
- C. Preliminary TAB Submittal:
  - 1. Prior to final inspection.
  - 2. A pdf file to Engineer.
  - 3. A pdf file to mechanical commissioning authority: As soon as possible after balancing work to facilitate spotchecking.
- D. Final Submittal: A pdf file to Engineer.
- E. The TAB report shall include, but not necessarily be limited to, the following general items:
  - 1. Summary remarks regarding problems.
  - 2. Initial, interim and final performance test data.
  - 3. Description of test procedures and equipment used.
  - 4. Systems' Drawings and/or schematics clearly marked to identify location of equipment tested, duct traverse location(s), location of system static pressure sensor, etc.
  - 5. Systems performance data sheets shall include design conditions, installed equipment information, and field test data for:
    - a. Air Systems:
      - 1) Design Conditions:
        - a) Air capacity.
        - b) System total static pressure drops and profiles of all air handling systems, including filters, coils, etc.
        - c) Motor horsepower and design brake horsepowers.
        - d) Fan speeds.
        - e) Fan curves or fan rating tables showing design conditions.
      - 2) Installed Equipment:
        - a) Equipment Manufacturer.
        - b) Equipment model numbers, sizes, types, etc.
        - c) Motor types, sizes and characteristics.

- d) Heater and starter types, sizes and characteristics.
- e) Drive types, sizes and speed range.
- f) Equipment ratings if different from design.
- g) Identification of all terminal devices, including outlets.
- h) Location of all smoke control devices.
- 3) Field Test Data - Initial and Final Test Readings For:
  - a) Air capacities.
  - b) Static pressures through units and unit components.
  - c) Equipment speeds.
  - d) Motor operating voltages and amperages.
  - e) Brake horsepower.
  - f) Operating performance plotted on fan curves or fan rating tables.
  - g) System schematic and notes including measured static pressure values, system static pressure sensor values, etc.
  - h) Airflow and static pressure data for all duct mains as balanced under typical total system operation. Report will not be accepted without airflow and static pressure profile (refer to Paragraph 3.3).
  - i) Identify each outlet or inlet as to location, area, size and fan system.
  - j) Required and field measured cfm for each outlet or inlet.
  - k) Identify each smoke control device and pressure differential and flow test data.

## 1.6 QUALITY ASSURANCE

### A. Qualifications:

- 1. TAB Field Technician Personnel:
  - a. Trained and experienced in the operation of the test and balance equipment.
  - b. Knowledgeable of the design of all systems scheduled for testing and balancing.
- 2. TAB Engineer:
  - a. A certified member of either the following organizations or trained in the practices thereof:
    - 1) AABC.
    - 2) NEBB.
    - 3) TABB.
  - b. Acceptable firms providing testing, adjusting, and balancing services include:
    - 1) Mechanical Testing Services, Grandville, Michigan.
    - 2) Great Lakes Balancing, Grand Rapids, Michigan.
    - 3) Third Coast Test and Balance, Grand Rapids, Michigan.
    - 4) Absolute Balancing Company, South Lyon, Michigan.
    - 5) International Test & Balance, Southfield, Michigan.
    - 6) Total Balance Company, St. Clair Shores, Michigan.

### B. Report Forms:

- 1. The report forms included in the appendix of the AABC Standard are incorporated in the work of this Section for the purpose of identifying the level of detail required for testing and reporting.
- 2. TAB engineer may use the AABC forms or other similar forms which present equivalent information in a logical format.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

#### A. Patching Materials:

- 1. Comply with requirements as specified in other Sections where applicable to provide materials essentially and functionally identical to original installation before testing and balancing work.
- 2. Maintain the integrity of systems for air tightness, water tightness, and durability of finish.

### 2.2 INSTRUMENTS

- A. Instruments used for TAB work shall be as indicated in the referenced standards.

- B. Calibration:
  - 1. Instruments to have been calibrated within one year of start of TAB work.
  - 2. Appropriate documentation shall be made available to the Engineer on request.

### PART 3 - EXECUTION

#### 3.1 PROCEDURES

- A. General:
  - 1. Determine what actual performance characteristics are deemed proper during system tests.
  - 2. If the design supply, return or exhaust air quantities for a space create a space pressure other than neutral, or if a space is indicated to be a certain pressure, provide balancing to the extent required to achieve this designed pressure.
  - 3. During heating (and cooling) season of the first year of operation, at times when directed, make final adjustments until all occupants are reasonably satisfied and all equipment is operating at peak efficiency.
  - 4. Confirmation of proper equipment operation must be through actual observation. Computer simulation and sensor readouts are not acceptable proof.
  - 5. Air quantities at individual registers or diffusers shall be adjusted to within 10% of quantities indicated on the Drawings and total air quantity handled by each system to within 5% of the quantity indicated or specified. Water systems balance to within 5% of the quantity indicated or specified.
- B. Air Systems:
  - 1. General:
    - a. Adjust and set all dampers, deflecting vanes, discharge vanes and accessory items to achieve proper air distribution and patterns in all parts of the air supply, return and exhaust systems:
      - 1) Determine air flow and static pressure in all branch ducts by velocity traverse and balance out all branches by means of branch duct manual dampers.
      - 2) Balance terminal outlets on each branch duct using volume dampers in run-out duct to the outlet, not the terminal outlet dampers.
    - b. Mark final balance position for all dampers which are not left 100% open with an indelible pen.
    - c. Adjust and set all belted fan speeds as required to attain proper total air flow.
    - d. Measure supply fan total air flow at both the full return air and full outdoor air damper positions.
    - e. Make smoke gun tests, if necessary, to check for drafts and make final adjustments and settings for optimum comfort conditions.
  - 2. Methods: Acceptable procedures for obtaining performance measurements are listed below:
    - a. CFM Airflow for Duct Sections:
      - 1) Duct traverse as specified in SMACNA Manual "HVAC Systems - Testing, Adjusting and Balancing," Chapter V, Section 4-B, using a pitot tube and inclined manometer.
      - 2) Acceptable Methods:
        - a) Pitot tube array with reading by inclined manometer.
        - b) Electronic manometer.
        - c) Hot-wire anemometer.
    - b. CFM airflow, for room supply, return and exhaust, at diffusers, registers and grilles: Use airflow hood.
    - c. Fan TSP: Use inclined manometer.
    - d. Equipment Pressure Drops: Use inclined manometer.
    - e. Air Temperatures: Use thermometer.
    - f. Smoke Testing: Use a non-hazardous material.
    - g. CFM Differential Airflow Reading:
      - 1) Block door entrance leaving 1 or 2 square foot measured opening.
      - 2) Read opening with thermal anemometer.
    - h. Differential Pressure: In cases where sensors for differential pressure are permanently installed, differential pressure may be read directly using an Electronic Digital Manometer.
  - 3. TAB Procedures for Air Systems:
    - a. Check all motorized, balancing and gravity relief dampers for proper position.
    - b. Inspect coils, filters and fans for cleanliness.
    - c. "Bump" motor to check for proper fan rotation.

- d. Check unit performance including:
  - 1) Fan speed.
  - 2) Amperage and voltage.
  - 3) Inlet, discharge and total static pressures at fan.
  - 4) Supply air volume of fan by taking duct traverse in discharge duct or zone ducts.
- e. Note: Check unit performance in both 100% outside air and 100% return air positions, including static pressures across individual equipment components.
- f. Set outside air motorized damper at proper minimum position.
- g. See that necessary adjustments or changes are made to achieve design airflow capacities or consult Engineer if change(s) required are beyond the scope of the TAB contract.
- h. Balance Medium and High Velocity Ductwork:
  - 1) Measure inlet static pressure and airflow at all terminal unit inlets through actual transverse. Flow sensor readings are not acceptable.
  - 2) If terminal unit has constant volume regulator or manual adjustment damper, make certain the correct maximum amount of air is being delivered.
  - 3) All measurements should be taken only when system is operating under normal operating conditions.
  - 4) If system is variable volume, set up diversity conditions where applicable and record static pressure at sensor(s).
  - 5) Set terminal unit minimum airflow capacities where applicable.
- i. Balance Low Velocity Ductwork:
  - 1) Take traverse and static pressure readings in main branch ducts and set balancing dampers for approximate correct distribution of air.
  - 2) Proportionately balance all branch ducts.
  - 3) Proportionately balance all outlets and inlets.
  - 4) Make smoke gun tests to check for drafts and make final settings for optimum comfort conditions in occupied space.
  - 5) Recheck supply air unit performance and make any necessary final adjustments. Include allowances for wet coil, dirty filters, and other normal operating conditions which may reduce air flow.
  - 6) Record final measurements as required.

### 3.2 FIELD QUALITY CONTROL

- A. Preliminary Review and Analysis:
  - 1. If after standard balancing procedures have been carried out and readjustments attempted, the system does not perform as specified, Engineer shall be notified at once.
  - 2. All "as is" field data shall be submitted in a preliminary report for review and analysis.
  - 3. Manipulation of system to achieve air flow and balance without meeting intended and specified total system air flow will not be accepted in a balance report. Should this occur, rebalance shall be at the Contractor's expense.
- B. Final Inspection: Prior to final acceptance, all systems shall be operated to test performance as directed to the satisfaction of the Engineer:
  - 1. Steam and water shall circulate throughout entire system without noise, evidence of leaks and trapping or air-binding.
  - 2. Air in ducts shall circulate without excessive noise.
  - 3. Motors, fans and other equipment shall operate without excessive noise or vibration.
  - 4. Systems shall be balanced to operate within stated tolerances. If any heating unit, chilled water cooling coil, or air outlet does not operate within the stated tolerances, then the entire system shall be considered out of balance and shall be readjusted until all units are within the stated tolerances.
  - 5. Heating, ventilating and air-conditioning systems shall maintain uniform temperatures without drafts.
  - 6. Burners shall be tested and set for high efficiency and smokeless combustion.
- C. Testing:
  - 1. TAB engineer shall coordinate with Commissioning Authority to schedule access to site to perform air and hydronic system testing to whatever extent Commissioning Authority determines is necessary to verify accuracy of mechanical systems TAB report.
  - 2. TAB engineer will repeat system testing, adjusting, and balancing until Commissioning Authority and Engineer verifies accuracy of data.



### 3.3 STATIC PRESSURE AND AIR FLOW PROFILE

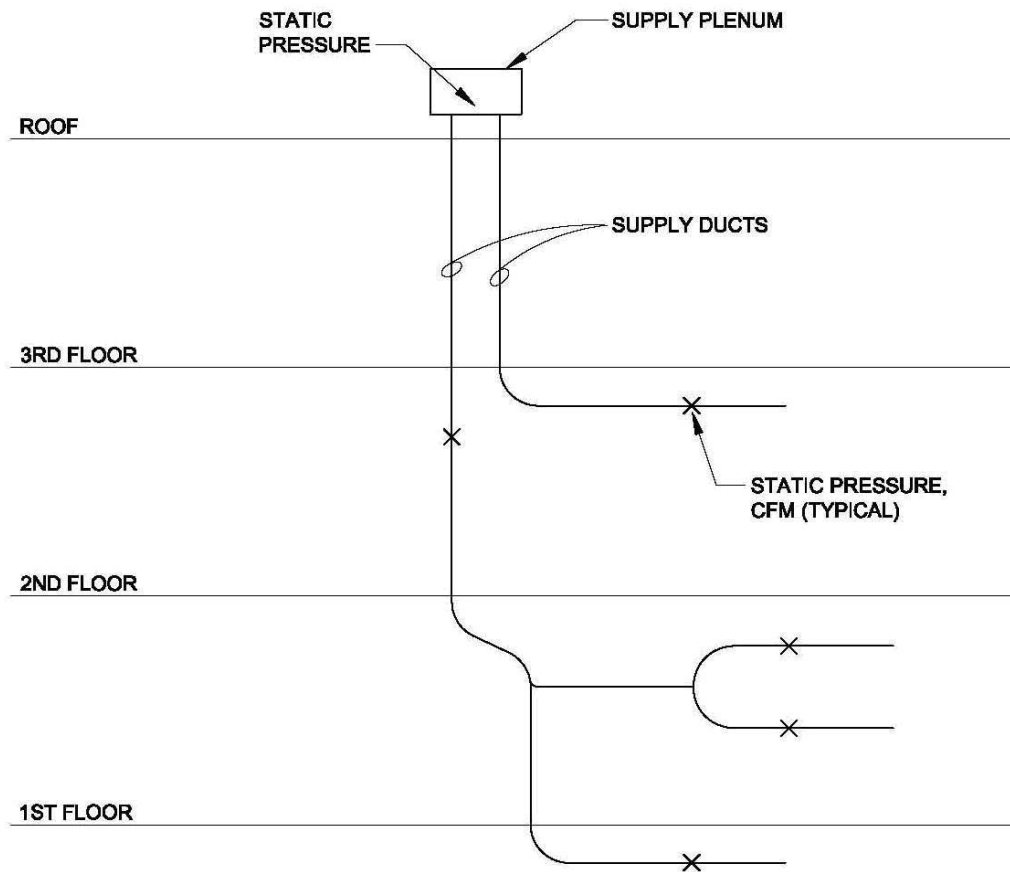
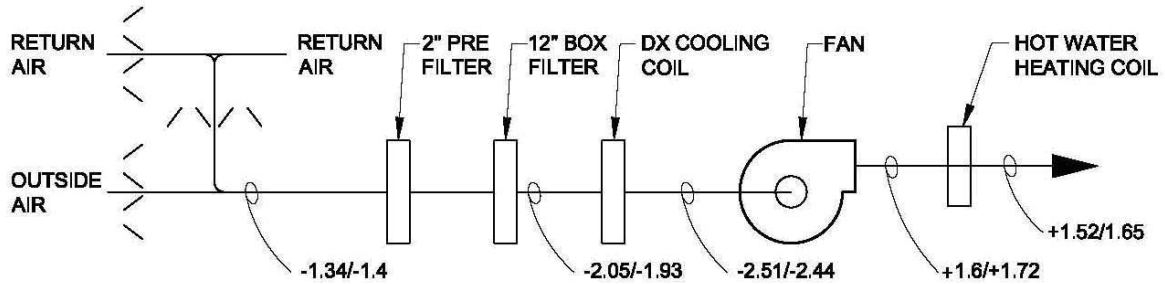
- A. Provide a static pressure and air flow profile diagram similar to Exhibit A attached:
  - 1. Air flow readings shall be based on a duct traverse.
  - 2. Data shall reflect actual coincident system performance established at total system balance:
    - a. Throttling of one branch below design to obtain design performance in another is not acceptable. Refer to Paragraph 3.2.A.
    - b. Diversity in variable air volume systems shall be reflected on profile diagram.
  - 3. Provide data for each duct main and a minimum of one set of readings for each floor for multiple floor systems.

### 3.4 PRE TEST AND BALANCE CHECKLIST

- A. Contractor shall copy the following Pre Test and Balance Checklist (Exhibit B, attached) and submit one completed checklist for each AHU, pump, chiller, boiler, cooling tower, fan, cabinet heater, and unit heater.
- B. TAB engineer may be entitled to be compensated for additional time required due to failure of other Subcontractors to properly complete their work.

**SCHEMATIC AND NOTES:**

**STATIC PRESSURE AT MAXIMUM OUTSIDE AIR/MINIMUM OUTSIDE AIR**



**STATIC PRESSURE PROFILE AT  
FINAL BALANCED CONDITIONS  
NO SCALE**

**EXHIBIT A**

**EXHIBIT B  
PRE TEST AND BALANCE CHECKLIST**

Equipment Tag No. \_\_\_\_\_ Date: \_\_\_\_\_

As an aid to properly interface work between trades and prevent unnecessary return visits for everyone concerned, the TAB engineer requires that the following list of items be completed by the Mechanical Subcontractor prior to any testing and balancing of air and hydronic systems.

Work required is as follows:

<input checked="" type="checkbox"/>	Item No.	Description
	1.	Static pressure control sensors shall be installed in locations indicated on contract documents.
	2.	Variable frequency controllers installed on fan drives shall be properly set up for minimum to maximum speed positions.
	3.	Fan rotation is correct.
	4.	Fan RPM is to be set after fan performance test by Test and Balance Contractor, however, initial installed RPM shall be within 10 percent of what was intended per equipment submittal.
	5.	Verify that fan is running within motor nameplate amp draw at initial installed RPM.
	6.	Balancing dampers shall be installed in locations shown on Contract Documents.
	7.	Damper operators shall be installed with provisions for access and not covered with insulation.
	8.	All (normal operational) dampers shall be set and locked in the 100 percent open position.
	9.	All fire dampers shall be open with fuse links installed and any props removed. Any motor operated fire and smoke dampers are operating correctly.
	10.	All filters shall be in place, including clean construction filters installed upstream.
	11.	Terminal units shall be functioning with thermostat.
	12.	Reverse acting (R.A.) thermostat shall be with N.O. terminal boxes and direct acting (D.A.) thermostat shall be with N.C. terminal boxes.
	13.	All (normal operational) valves shall be set in 100 percent open position
	14.	Memory devices shall be installed on all specified balancing valves
	15.	All exhaust fans shall be wired, operable and in correct rotation.
	16.	All multiple exhaust duct system balance dampers shall be installed and set 100 percent open.
	17.	All relief air or backdraft dampers shall be set for proper operation, i.e., just closing.

END OF SECTION 23 05 93

## SECTION 23 07 13 – DUCT INSULATION

### 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 furnishing and installation of thermal insulation applied to external surfaces of ductwork and air handling devices. Internal acoustical duct liner is not included in the work of this Section. Coordinate this work with duct liner requirements in accordance with Division 23 Section "Sound and Vibration Control for HVAC."

#### 1.3 REFERENCES

- A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with the following:
  - 1. ASTM Specifications:
    - a. C411 – Standard Test Method for Hot Surface Performance of High Temperature Thermal Insulation.
    - b. C553 – Mineral Fiber Blanket and Thermal Insulation for Commercial and Industrial Applications.
    - c. C612 – Mineral Fiber Block and Board Thermal Insulation.
    - d. E84 – Standard Test Method for Surface Burning Characteristics of Building Materials.
    - e. E119 – Standard Test Methods for Fire Tests of Building Construction and Materials.
    - f. E814 – Standard Test Method for Fire Tests of Through-Penetration Fire Stops.
    - g. D1970 – Standard Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection.
  - 2. NFPA Standard:
    - a. 90A - Installation of Air Conditioning and Ventilating Systems.
    - b. 255 - Surface Burning Characteristics of Building Materials.
  - 3. SMACNA: MF-1 - Mechanical Fastener Standard.
  - 4. ASHRAE Standard: 90.1 – 2019 Energy Efficient Design of New Buildings Except Low-rise Residential Buildings, with state amendments.
  - 5. Underwriter's Laboratories:
    - a. UL 1978 – Standard for Grease Ducts.
    - b. UL-181 – Factory-Made Air Ducts and Air Connectors.

#### 1.4 SUBMITTALS

- A. Manufacturer's Literature: For all thermal materials.
  - 1. Manufacturer product data brochure.
  - 2. Thermal performance characteristics - "K" Values.
  - 3. Details of construction and installation.
  - 4. Compliance with standards and UL listing.
- B. Samples:
  - 1. Proposed substitutions for products other than those herein specified.
  - 2. Engineer's approval prior to installation.
  - 3. Fire barrier shall have the following ratings:
    - a. Flame Spread Maximum: 0.
    - b. Smoke Developed Maximum: 0.
    - c. In accordance with ASTM E84.

## 1.5 QUALITY ASSURANCE

- A. Fabrication and Installation Personnel Qualifications:
  - 1. Trained and experienced in the fabrication and installation of the materials and equipment.
  - 2. Knowledgeable of the design and the reviewed Shop Drawings.
- B. Regulatory Agencies Requirements:
  - 1. State and local codes and ordinances.
  - 2. Insulation, facing and adhesive shall have a composite rating:
    - a. 25 flame spread maximum.
    - b. 50 smoke developed maximum.
    - c. In accordance with NFPA 255.
  - 3. Fire barrier shall have the following ratings:
    - a. 0 flame spread maximum.
    - b. 0 smoke developed maximum.
    - c. In accordance with ASTM E84.

## 1.6 DELIVERY, STORAGE AND HANDLING

- A. Materials shall be delivered in original, unbroken, brand marked containers.
- B. Handle and store materials in a dry place in a manner which will prevent deterioration and contamination with foreign matter.
- C. Reject damaged, deteriorated, contaminated material, or showing evidence of moisture, and immediately remove from the Site. Replace removed materials with new materials at no additional cost to Owner.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Thermal Insulation:
  - 1. Owens-Corning.
  - 2. Johns Manville.
  - 3. Armacell.
  - 4. Certaineed.
  - 5. Rubatex.
  - 6. Knauf.
- B. Adhesives:
  - 1. Benjamin-Foster.
  - 2. Baldwin-Ehret-Hill.
  - 3. Childers.
  - 4. Foster.
  - 5. Armstrong.
  - 6. Goodloe & Moore.
- C. Jacketing (Aluminum or PVC):
  - 1. Pabco.
  - 2. Childers.
  - 3. Ceel-Co.
  - 4. O'Brien.
  - 5. Zeston.
- D. Waterproofing Membrane: MFM Building Products Corp.
- E. Fire Barrier:
  - 1. 3M.
  - 2. Unifrax Corporation "Fyrewrap."
  - 3. Thermal Ceramics "Fyre Master."

## 2.2 MATERIALS

- A. Rigid Fiberglass Board (R):
  - 1. Glass fibers bonded into rigid rectangular panels.
  - 2. Density: 6.0 lbs/cu ft.
  - 3. Thickness: As scheduled.
  - 4. Thermal Conductivity (k): 0.22 BTU-in/hr-SF - F degrees at 75 degrees mean.
  - 5. Facing: All service jacket (ASJ).
  - 6. Owens-Corning, #705; or equal in accordance with specified manufacturer.
  
- B. Semi-Rigid Fiberglass Board (S):
  - 1. Glass fibers formed into semi-rigid rectangular panels.
  - 2. Density: 3.0 lbs/cu ft.
  - 3. Thickness: As scheduled.
  - 4. Thermal Conductivity (k): 0.23 BTU-in/hr-SF - F degrees at 75 degrees F mean.
  - 5. Facing: Foil-reinforced-scrim kraft (FRK).
  - 6. Owens-Corning, #703; or equal in accordance with specified manufacturer.
  
- C. Flexible Duct Wrap (F):
  - 1. Glass fiber blanket, factory-laminated to vapor barrier facing.
  - 2. Density: 0.75 lbs/cu ft.
  - 3. Thickness: As scheduled.
  - 4. Thermal Conductivity (k): 0.30 BTU-in/hr-SF - F degrees at 75 degrees mean.
  - 5. Facing: FSK.
  - 6. Owens-Corning, Type 75; or equal in accordance with specified manufacturer.
  
- D. High Density Flexible Duct Wrap (F-HD):
  - 1. Glass fiber blanket, factory-laminated to vapor barrier facing.
  - 2. Density: 1.50 lbs/cu ft.
  - 3. Thickness: As scheduled.
  - 4. Thermal Conductivity (k): 0.25 BTU-in/hr-SF - F degrees at 75 degrees mean.
  - 5. Facing: FSK.
  - 6. Owens-Corning, Type 150; or equal.
  
- E. Fire Barrier Duct Wrap (FB):
  - 1. Non-asbestos inorganic blanket encapsulated with a scrim-reinforced foil.
  - 2. Zero clearance to the overlap or collar.
  - 3. 2-hour rating at 1.5-inch thickness, 2 layers required for grease ducts.
  - 4. 3M Fire Barrier Duct Wrap 615+; or equal.

## 2.3 COVERING

- A. Mastic (M):
  - 1. Cold Service: Two 1/8-inch wet coats of Benjamin-Foster #30-33 or Childers CP-33 vapor-barrier mastic reinforced with glass fabric.
  - 2. Hot Service and Outdoors: Weatherproof. Two 1/8-inch wet coats of Benjamin-Foster #46-50 or Childers CP-10 / CP-11 weather barrier mastic reinforced with glass fabric.
  
- B. Aluminum Jacket (A):
  - 1. 0.016-inch thickness.
  - 2. Moisture barrier backing.
  - 3. Smooth finish, anodized.
  - 4. Manufactured by Pabco; or as approved.
  
- C. Polyvinyl Chloride Covers (PVC):
  - 1. Ultraviolet resistant.
  - 2. 0.030-inch minimum thickness.
  - 3. Ceel-Tite 330; or equal by Topline or Zeston.

- D. Exterior Coating System (CS):
  - 1. 6 layers of aluminum foil.
  - 2. 4 layers of polyester film.
  - 3. Adhered to flexible elastomeric sheet in accordance with Manufacturer's written instructions.
  - 4. Resistant to moisture penetration and UV degradation without painting.
  - 5. ArmaTuff Plus by Armacell; or approved equal.
  
- E. Self-Adhering Sheet Type Membrane (WPM):
  - 1. Embossed Aluminum Sheet: 45 Mills (1.0 mm).
  - 2. Multiple layers of high-density cross-linked polymer film.
  - 3. Layer of rubberized asphalt adhesive.
  - 4. Vapor Permeance (ASTM E 96): .01 perms.
  - 5. Nail Sealability (ASTM D 1970): Pass.
  - 6. Heat Aging (ASTM D 794): Pass.
  - 7. Elongation (ASTM D 412): 450 percent.
  - 8. Tear Resistance (ASTM D 1424): 660 grams.
  - 9. Exceeds 25/50 Flame/Smoke Rating (ASTM E 84).
  - 10. Maximum Temperature: 175 degrees F (79 degrees C).
  - 11. Installation Temperature Range: Greater than 40 degrees F (4.5 degrees C).
  - 12. Flex-Clad 400 as manufactured by MFM Building Products Corp.

#### 2.4 MECHANICAL FASTENERS

- A. Impale Anchor:
  - 1. 12-gage galvanized steel.
  - 2. With self-adhesive pad.
  - 3. 2-inch speed washer.

#### 2.5 ADHESIVES

- A. Insulation-Adhesive and Tape: As recommended by Manufacturer of insulation.
- B. Canvas Adhesive: Foster 30-36, Childers CP-50 AMV-1; or approved equal.
- C. Hot Service Mastic: Foster, #46-50, Childers CP=10/11; or approved equal.
- D. Waterproofing Membrane Adhesive: MFM Spray Adhesive™ as manufactured by MFM Building Products Corp.

### PART 3 - EXECUTION

#### 3.1 PREPARATION

- A. Clean ductwork surfaces prior to applying insulation.

#### 3.2 INSTALLATION

- A. Follow insulation Manufacturer's recommended procedures.
- B. Thermal Insulation:
  - 1. Rigid insulation shall be attached with mechanical fasteners spaced no more than 16 inches center-to-center and no more than 3 inches from ductwork edges or insulation joints.
  - 2. Flexible wrap insulation shall be attached with 4-inch wide strips of insulation bonding adhesive spaced at 8 inches center-to-center. Adhesive shall be applied over entire surface of ductwork conveying or subjected to unconditioned outside air.
  - 3. Mechanical fasteners shall also be used on the underside of rectangular ductwork runs wider than 24 inches. Fastener spacing in accordance with A. above.

4. Allow maximum fullness at corners when using flexible wrap.
  5. Provide removable section of insulation with a protected edge over access doors and around damper operators to allow operation without damage to insulation.
- C. Waterproofing Membrane:
1. Apply waterproofing membrane in accordance with Manufacturer's instructions at locations indicated on the Drawings. Do not use as a substitute for banding, pinning or other means of securely attaching insulation and underlying materials.
  2. Apply membrane to clean, dry, primed metal ductwork and foil-faced rigid insulation boards. Do not apply over wet or non-rigid insulation.
  3. Apply membrane in accordance with Manufacturer's air, material, and surface temperature requirements. Minimum application temperature is greater than 40 degrees F (4.5 degrees C).
  4. Apply firm, uniform pressure with hand roller to entire membrane to ensure proper adhesion. Concentrate pressure at seams and on underside of ductwork.
  5. Ductwork mounted outside must be pitched to shed water to prevent ponding water.
  6. Apply membrane shingle fashion to shed water over, not against, laps.
  7. Do not terminate membrane on bottom of duct.
  8. Apply minimum 3 inches (76 mm) side laps and minimum 6 inches (152 mm) end laps for ductwork applications.
  9. Embed membrane to bottom of ducts over 24 inches (610 mm) wide in light continuous layer of adhesive applied to insulation facer.
  10. Apply membrane to bottom of insulated ducts over 24 inches (610 mm) wide using mechanical attachment, in addition to adhesive, in accordance with Manufacturer's instructions. Install pins on 12 inches (305 mm) centers with rows staggered.
  11. Apply adhesive to areas where special adhesion requirements exist, including duct bottoms, flashings, transitions, joints, elbows, valves, tees, and other fittings.
- D. Joints and Sealants:
1. Joints shall be tightly butted and sealed with 3-inch (minimum) foil reinforced kraft tape. Fastener penetrations and any other punctures in the vapor barrier facing shall also be taped and sealed with vapor barrier adhesive. Seams, penetrations, and punctures shall also be vapor sealed with a 4-inch wide coating of vapor barrier mastic.
  2. Flexible wrap insulation joints shall be made with a 2-inch overlap of the vapor barrier secured with 9/16-inch outward clinching staples spaced 6 inches center-to-center.
  3. Taped joints at patches on rigid insulation shall be burnished or ironed on to ensure a tight seal.
  4. Use double tape strips when joining faced with unfaced insulation.
- E. PVC:
1. Weld longitudinal seams together with welding adhesive as supplied by cover Manufacturer.
  2. Overlap adjacent jacketing 3/4-inch and weld circumferential seams together with welding adhesive.
  3. Overlap fitting covers to adjacent duct insulation jacketing. Weld longitudinal and circumferential seams together with adhesive.
- F. Damper Handles:
1. Seal all exposed edges of insulation around handles.
  2. Tie a 2-foot long piece of bright orange ribbon on handle so it hangs down allowing easier visual locating of dampers.

### 3.3 APPLICATION SCHEDULE

A. Insulation Material Type:

- R = Rigid fiberglass board  
S = Semi-rigid fiberglass board  
F = Flexible duct wrap  
F-HD = High density flexible duct wrap  
L = Internal liner – Refer to Division 23 Section "Sound and Vibration Control for HVAC" for requirements  
FB = Fire barrier



B. Covering (Refer to Part 2, Paragraph 2.3, of this Specification Section):

- M = Mastic
- A = Aluminum jacket
- P = Paint in accordance with Division 09 Section "Interior Painting"
- PVC = Polyvinyl chloride jacket
- CS = Exterior coating system
- WPM = Waterproofing membrane

C. Flanged Ductwork: Insulation thickness indicated shall be increased to be at least a 1/2-inch thicker than the flange depth.

D. Coordination of Insulation:

1. Requirements for internal liner for sound control are in addition to other requirements above. However, thickness requirements for external insulation may be reduced by up to 1-1/2-inch when duct liner is used.
2. Refer to Division 23 Section "Sound and Vibration Control for HVAC" for acoustic duct liner requirements.

E. Definitions:

1. Concealed: A space concealed from view or otherwise accessible only through the removal of ceiling tiles, access panels, or building construction components.
2. Exposed: Not concealed.
3. Plenum: A ceiling plenum or other concealed space used to transport air.
4. Heated Space: A space with a direct supply of heating from HVAC system or equipment in space.
5. Warm Space: A space within the building thermal barrier and also within the building vapor barrier but not having a direct supply of heating.
6. Unheated Space: A space within the building but outside of either the building thermal barrier or the building vapor barrier.
7. Cooled Space: A space with a direct supply of cooling.
8. Outside Air and Mixed Air: Unconditioned outside air, partial outside air, or relief or exhaust air downstream of last damper and subjected to unconditioned outside air.

F. Duct Insulation Schedule:

DUCT INSULATION SCHEDULE - ASHRAE 90.1 2019							
Duct System	Internally Lined	Insulation Type	External Insulation	Double Wall Insulated	Cover	Not Insulated	Notes
SA Upstream of VAV Boxes in return air plenum	-	F	1.5"	Note 5	-	-	1
SA Downstream of VAV boxes in return air plenum	-	F	1.5"	-	-	-	1
SA and RA in unconditioned ceiling plenum (if RA is fully ducted)		F-HD	2"				2
RA in plenum	-	-	-	Note 5	-	Y	
Rectangular SA, RA and Relief Ducts in Equipment/Mech Rooms	-	R	1.5"	Note 5	-	-	2
Round/Oval SA, RA, and Relief Ducts in Mech Rooms		F	1.5"	Note 5	A		8
Exhaust and Relief from control or BD damper to outside wall or roof	-	R	1.5"	-	-	-	2
Transfer Ducts	1"	L	-	-	-	-	
Mixed Air Ducts and Plenums	-	R	1.5"	-	-	-	2

DUCT INSULATION SCHEDULE - ASHRAE 90.1 2019							
Duct System	Internally Lined	Insulation Type	External Insulation	Double Wall Insulated	Cover	Not Insulated	Notes
Exterior rectangular SA, RA and Exhaust	-	R	2" (Note 3) 3" (Note 4)	-	WPM	-	4
Exterior Round	-	E	3"	-	A [ CS ]	-	4
SA and RA in attic above ceiling insulation	-	F-HD	2" (Note 3) 3 (Note 4)	-	-	-	4
SA and RA in attic below roof insulation	-	F-HD	2"	-	-	-	2
SA and RA in unconditioned or heated only space	-	S	1.5"	-	-	-	2
OA Ducts - Exposed		R	2" (Note 3) 3" (Note 4)	-	-	-	4,7
OA Ducts - Concealed		R	2" (Note 3) 3" (Note 4)	-	-	-	4,7
OA Ducts - Concealed in plenum		F-HD	3"	-	-	-	4,7
Exhaust Air							
Notes:							
1. Minimum installed R-value = 4.2 2. Minimum installed R-value = 6.0 3. Minimum installed R-value = 8.0 4. Minimum installed R-Value = 12.0 5. Supply and Return ductwork within 15' of AHU shall be 2" double wall construction provided with 2-inch acoustical liner with no exterior insulation. 6. Wrap with 2 layers of 1.5" thick fire barrier insulation 7. Includes Combustion Air intakes and plenums. 8. Provide cover on ductwork below 8'-0" AFF.							

G. Internal Duct Liner:

1. At Contractor's option, with Engineer's pre-approval, Contractor may substitute internal acoustic duct liner (Type L) for insulation listed at sufficient thickness to provide equivalent thermal insulating value.
2. Where round or flat-oval ductwork is used, pre-insulated, perforated lined ductwork may be used in lieu of internal acoustic liner.
3. Internal duct liner is not allowed in a duct conveying any amount of unconditioned or unfiltered air.
4. Refer to Division 23 Section "Sound and Vibration Control for HVAC" for acoustic duct liner requirements and Division 23 Section "Metal Ducts" for round and flat oval pre-insulated, perforated lined ductwork.

END OF SECTION 23 07 13

## SECTION 23 08 00 – COMMISSIONING OF HVAC

### 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. Refer to Division 01 Section "General Commissioning Requirements" for detailed explanation of commissioning work. Section also contains sample Cx Plan, construction checklist, and functional test.

#### 1.2 SUMMARY

- A. This Section lists mechanical systems to be commissioned. The commissioning process is described in detail in the commissioning plan (Refer to Division 01 Section "General Commissioning Requirements").

#### 1.3 SYSTEMS TO BE COMMISSIONED

- A. In accordance with the Michigan Commercial Building Energy Code, HVAC control systems shall be tested to ensure that control elements are calibrated, adjusted, and in proper working condition.
- B. The following systems will be commissioned:
  - 1. Air Handling Systems:
    - a. Air handling units.
    - b. All associated coils, etc.
    - c. Return and exhaust fans.
    - d. Ductwork.
    - e. Room temperature controls.
    - f. VAV terminals.
  - 2. General Exhaust Systems: Fans, ductwork, controls.
  - 3. Building Management and Control System (BMCS):
    - a. Operator Interface functions, graphics and webpages.
    - b. Actuators.
    - c. Controls sensors.
    - d. Control valves and dampers.
    - e. Other miscellaneous alarms.
  - 4. Terminal Heating and Cooling Units
    - a. Cabinet Unit Heaters

### PART 2 - PRODUCTS

Not used.

### PART 3 - EXECUTION

Not used.

END OF SECTION 23 08 00

## SECTION 23 09 00 – INSTRUMENTATION AND CONTROL FOR HVAC

### 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 design, furnishing and installation of HVAC instrumentation and controls (HI&C) systems:
  - 1. The Work of this Section also includes the integration of the Work of other trades as necessary to provide a complete operational control system as defined in the Contract Documents.
- B. Major items unique to the work of this Section:
  - 1. Direct digital control (DDC) hardware.
  - 2. DDC software.
  - 3. All remote sensing devices and interconnecting wiring or tubing.
  - 4. All secondary control devices including, but not necessarily limited to, the following:
    - a. Thermostats and humidistats.
    - b. Temperature and humidity sensors.
    - c. Primary and secondary controllers.
    - d. Automatic valves and dampers.
    - e. Damper and valve operators.
    - f. Relays.
    - g. Control panels.
    - h. Operator interface.
    - i. Network devices.
    - j. Miscellaneous sensors.
  - 5. Electric power supply source.
  - 6. Conductor and conduit.
  - 7. Necessary appurtenances to make a complete and functional system to satisfy the functional intent.
  - 8. Final and complete operational demonstration.
  - 9. Mechanical testing, adjusting, and balancing.
- C. Mechanical systems included in the Work of this Section:
  - 1. Except as specifically described below, it is the work of this Section to provide, install and integrate complete control of the HVAC systems, including, but not limited to the following:
    - a. Air handling unit controls except smoke detectors.
    - b. Terminal unit controls.
    - c. Ventilation system controls.
- D. Integration:
  - 1. Provide communication interface and network integration for the following packaged control systems furnished under the Work of other Sections:
    - a. Package rooftop units as specified in Division 23 Section "Packaged, Outdoor Heating and Cooling Units."
    - b. Variable air volume boxes as specified in Division 23 Section "Air Terminal Units."
    - c. Smoke detectors in ductwork and air handling units.
  - 2. Existing Control Equipment:
    - a. Provide for interface between new controls installation and Owner's existing control and building management systems:
      - 1) As indicated on the Drawings.
      - 2) As required to satisfy the functional intent description of this Section.
    - b. All existing equipment is assumed to be fully functional and in proper working order as it relates to the work of this Section for Base Bid.

### 1.3 DIVISION OF WORK

- A. In accordance with the General Conditions, Contractor is responsible for dividing the Work among the Subcontractors and Suppliers and for delineating the work to be performed by specific trades.
- B. The following are suggestions as to how the Work may be divided. This is not intended to be a complete list of all the Work:
1. Mechanical Subcontractor:
    - a. Install automatic valves and separable wells that are specified to be supplied by HI&C Subcontractor.
    - b. Install all automatic dampers unless furnished as a factory mounted item with HVAC equipment.
    - c. Provide all necessary blank-off plates (safing) required to install dampers that are smaller than duct size.
    - d. Assemble multiple section dampers with the required interconnecting linkages and extend required number of shafts through ductwork for external mounting of damper motors.
    - e. Provide necessary sheet metal baffle plates to eliminate stratification and provide air volumes specified. Locate baffles by experimentation and seal permanently in place only after all stratification problems have been eliminated.
    - f. Provide access doors or other approved means of access through ducts for service to control equipment.
    - g. Mount duct smoke detectors.
  2. Electrical Subcontractor:
    - a. Provide conduit, conductors, and wire for all 120 volt or higher devices which interlock equipment provided under Division 23 with equipment and devices provided under other Divisions of the Specifications as indicated on Electrical Drawings and Division 26 Specifications.
    - b. Provide power to DDC panels as indicated on the Drawings.
    - c. Furnish smoke detectors.
    - d. Furnish power and control wiring of duct smoke detectors. Termination by HI&C Subcontractor.
    - e. Provide devices, conduit and wiring as indicated on Electrical Drawings.
  3. HI&C Subcontractor:
    - a. Be responsible for controls systems operation in accordance with sequence of operations description defined in on Drawings.
    - b. Furnish all automatic dampers, valves, operators, and linkages.
    - c. Provide a detailed schedule for the Mechanical Subcontractor of all automatic dampers and valves requiring their assembly or installation as suggested above.
    - d. Provide 120 volt and low voltage power to all valve/damper motors requiring same.
    - e. Wire all 120 volt flow, pressure and temperature sensing devices.
    - f. Coordinate with Electrical Subcontractor for smoke detector interface compatibility and functional intent.
    - g. Make final terminations to controlled components, including terminations from smoke detectors.
    - h. Provide conductors and conduit, including low voltage and 120 volt, as required to provide functional intent, except as specifically indicated otherwise on Drawings or in the specifications.
    - i. Provide all interface devices necessary for required communication to other systems.
    - j. Provide for power supply for all DDC panels that are required that are in addition to those indicated on the Drawings.
    - k. Operate all temperature control devices to confirm sequence of operations. Support Commissioning Authority in functional performance testing in accordance with the requirements of Division 23 Section "Commissioning of HVAC."
    - l. Provide certification to Commissioning Authority of complete control system function and calibration.
  4. Commissioning Authority (CxA): Provide verification of system function in conformance with design intent, including selected sensor calibration.

### 1.4 REFERENCES

- A. Except as herein specified or as indicated on the Drawings, the Work of this Section shall comply with the following:
1. ANSI - American National Standards Institute:
    - a. ANSI/ISA S5.1 - 1984 - Instrumentation Symbols and Identification (Joint Standard with ISA - Instrument Society of America).

- b. ANSI X3.4 (ASCII).
- c. ANSI/ASHRAE Standard 135 - BACNet.
- d. ANSI/EIA Standard 709 - Control Network Protocol Specification (LONWorks).
2. EIA - Electronic Industry Association: EIA Standard RS-232-C.
3. NFPA – National Fire Protection Association:
  - a. 70 – National Electrical Code.
  - b. 90A – Standard for the Installation of Air-Conditioning and Ventilation Systems.

## 1.5 DEFINITIONS

- A. Where applicable, the terminology used herein uses the definitions listed in ASHRAE Standard 13.
- B. Other definitions used include:
  1. Low Voltage:
    - a. Voltage less than 120V single phase, typically 24V AC.
    - b. Low voltage is used primarily for communication and control of devices.
  2. Large Dampers: Greater than 133-inch/pound torque required or 30 square feet.
  3. DDC: Direct digital controls.
  4. IP: Internet protocol.
  5. LAN: Local area network.
  6. HVAC: Heating, ventilating and air conditioning systems. Generally, the work of Division 23.
  7. Primary Controller: A device that includes IP to field bus router, automatic time scheduling, trend logging, alarm handling, and supervisory logic control functionality. Sometimes referred to as a Building Controller.
  8. Secondary Controller:
    - a. Advanced Application Controller: A controller with provisions and the control logic for all of the physical inputs and physical outputs associated with a single mechanical component such as a terminal unit, air-handling unit, chiller or boiler. An Advanced Application Controller may or may not have data management features such as time schedules, trend data storage and alarm message generation capabilities. These features may be provided by the Building Controller.
    - b. Application Specific Device or Controller: A sensor, controller, or end device that is pre-programmed by the vendor. It may have physical inputs and physical outputs. The control logic, while not programmable, may be configurable through the use of configuration parameters. The application may require input network variables and may send output network variables onto the network.
  9. Control Logic Diagram: A graphical representation of control logic for the multiple processes that make up a system. Logic symbols are used to represent:
    - a. Input/Output (I/O) data.
    - b. Control functions such as PID, two-position control, switches, etc.
    - c. Math functions such as addition, subtraction, multiplication, division, etc.
    - d. Boolean functions such as greater than, less than, equal to, etc.
    - e. Limit functions such as maximum, minimum, ramps, etc.
  10. Enterprise Level Data Manager (ELDM): A logic only device (controller without I/O) that is installed on the building LAN as the first node beneath the IP router. This device shall be programmable and be from the same Manufacturer that provides the enterprise level server and operator workstation software. The enterprise level data manager may be multiple identical devices installed on the building LAN in series in order to have sufficient capacity to support the building level controls. The enterprise level data manager may be combined in a single device with the IP router. The enterprise data manager serves 3 functions:
    - a. Time Schedules: Time schedule algorithms shall reside in the enterprise level data manager. Occupancy/energize commands shall be broadcast to the building level controllers in the number required by the sequence of control.
    - b. Trend Data Storage: The enterprise level data manager shall collect data from the building level controls at specified intervals and store the data for periodic uploading to the server. Polling communication techniques are acceptable for data collection by the data manager.
    - c. Alarm Generation: The enterprise level data manager shall receive binary alarm variables from the building level controllers and transmit this data to the alarm handling software module within the server and operator work stations. Receipt of alarm data from the building level controls shall be based on broadcasting from the building level controls and not based on polling by the enterprise level data manager.

11. JACE: Java Control Engine. A term used within the Niagara Framework to describe an enterprise level data manager:
12. Managed Communication: The transmission of data from a controller to a data manager, which in turn rebroadcasts the data to a second controller. The data manager may be referred to as a network controller
13. Peer to Peer Communication: Data is broadcast from its origin and is received by the final device requiring the data without being received and retransmitted by a third device.
14. Standalone Controller: A standalone controller has provisions for all of the physical inputs and physical outputs associated with a single mechanical component such as a terminal unit, air handling unit, chiller or boiler. The controller shall also have embedded in it all of the control logic that associated the physical inputs to the physical outputs. A standalone controller will also have data management features such as time schedules, trend data storage and alarm message generation capabilities.
15. TCP/IP: Transmission Control Protocol/Internet Protocol. A basic communications protocol in a private network, either an intranet or an extranet.
16. Web Server: A software package installed on a primary/secondary controller or ELDM that provides for operation access to the Enterprise Level system from a computer on the LAN, using only a browser.

## 1.6 DESIGN AND PERFORMANCE REQUIREMENTS

- A. System layout and design responsibility are included as Work of this Section:
  1. Details of construction, quantities, components, and accessories indicated on the Drawings and in the Specifications are minimum requirements.
  2. Increases in system component requirements beyond these minimums that are determined by the system designer to be necessary to provide the functional intent and for a complete system shall not be a basis for an increase in cost to Owner. Refer to control drawings for functional intent.
  3. Input/Output Summary Table: Refer to the Input/Output Summary Table at the end of this Section for a listing of the minimum points required for monitoring and functional intent. All additional points necessary for the functional intent, whether listed or not, are part of this Work.
- B. Comply with the following performance requirements:
  1. Graphic Display: Display graphic with minimum 20 dynamic points or as required to display required data.
  2. Graphic Refresh: Update graphic with display with current data within 8 seconds.
  3. Object Command: Reaction time of less than 2 seconds between operator command of a binary object and device reaction.
  4. Object Scan: Transmit change of state and change of analog values to control units or workstation within 6 seconds.
  5. Alarm Response Time: Annunciate alarm at workstation within 45 seconds. Multiple workstations must receive alarms within 5 seconds of each other.
  6. Program Execution Frequency: Run capability of applications as often as 5 seconds, but selected consistent with mechanical process under control.
  7. Performance: Programmable controllers shall execute DDC/PID control loops, and scan and update process values and outputs at least once per second.
  8. Reporting Accuracy and Stability of Control: Report values and maintain measured variables within tolerances as follows:
    - a. Space Temperature:  $\pm 1$  degree F (0.5 degree C).
    - b. Ducted Air Temperature:  $\pm 1$  degree F (0.5 degree C).
    - c. Outside Air Temperature:  $\pm 2$  degree F (1.0 degree C).
    - d. Dew Point Temperature:  $\pm 1$  degree F.
    - e. Temperature Differential: Plus or minus 0.25 degree F (0.15 degree C).
    - f. Relative Humidity:  $\pm 2\%$ .
    - g. Airflow (Pressurized Spaces):  $\pm 3\%$  of full scale.
    - h. Airflow (Measuring Stations):  $\pm 5\%$  of full scale.
    - i. Airflow (Terminal):  $\pm 10\%$  of full scale.
    - j. Air Pressure (Space):  $\pm 0.01$ -inch wg (2.5 Pa).
    - k. Air Pressure (Ducts):  $\pm 0.1$ -inch wg (25 Pa).
    - l. Carbon Monoxide:  $\pm 5\%$  of reading.
    - m. Nitrogen Dioxide:  $\pm 5\%$  of reading.
    - n. Carbon Dioxide:  $\pm 50$  ppm.
    - o. Electrical:  $\pm 5\%$  of reading.

## 1.7 SUBMITTALS

- A. Submit the following in accordance with Division 01 Section "Submittal Procedures."
- B. Bid Submittals:
1. A description of the proposed system, including a schematic diagram showing system architecture and all major components. Indicate all controllers and devices at the LAN layer.
  2. Original Manufacturer's literature for each type of controller, processor and input/output device that is shown on the schematic diagram.
  3. Written verification that specified sequences of operation can be followed and performance requirements met, or a written list of variances required.
  4. Written verification that all accessibility and interoperability requirements will be met, or a written list of variances required.
  5. A specific description of proposed hardware and software expansion capabilities beyond the requirements described herein.
  6. A sample logic schematic for at least 1 system similar to one used in this project.
  7. The Bidder may, at Engineer's option, be required to make a personal presentation of the proposed system to Owner and Engineer prior to award.
  8. Installer's Qualifications: Include certifications, experience of similar projects and other evidence of qualifications for this Work.
- C. Submittals Prior to Construction:
1. A description of the complete system, including a schematic diagram showing system architecture and all major components, cabinets, panels, sensors, controllers, hubs and operated devices, and required cabling between each.
    - a. Include any environmental and space requirements for equipment.
    - b. Anticipated deviations from performance and response time specified.
    - c. A layout drawing indicating locations of controllers and major devices.
  2. Front-End Hardware and Software:
    - a. Dimensions and installation requirements.
    - b. Equipment and material specification data.
    - c. Function/identification labeling.
    - d. Clearly mark (in ink) all preprinted information.
  3. Sensors, Controllers, Actuators and Related Devices:
    - a. Complete system wiring diagrams and/or piping schematic including motor starters.
    - b. Specification sheets on all individual control system components, including rated accuracy of sensors.
    - c. Schedule of valves and dampers including size and performance characteristics.
  4. Complete Descriptions of Operation:
    - a. Written sequences for software and hard-wired controls.
    - b. A sequence of control for each system being controlled. Include the following as a minimum.
      - 1) Process control sequence for each end device.
      - 2) Supervisory logic sequence of control for each system.
      - 3) The impact of each global application program on the sequence of control (Example: Demand Control).
      - 4) A list of all physical inputs and outputs associated with each sequence.
      - 5) Within the sequence of control, all application parameters that are to be user adjustable from an operator work station (OWS) shall be annotated with (adj) after the name of the parameter. This shall include setpoints, reset schedule parameters, calibration offsets, timer settings, control loop parameters such as gain, integral time constant, sample rates, differentials, etc.
      - 6) Within the sequence of control, all calculated values that are to be viewable at the OWS shall be annotated with (rpt) after the name.
      - 7) All points that shall be subject to manual control from an operator workstation.
      - 8) A list of all alarm points, a description of the alarm and a description of the alarm criteria.
      - 9) A list of all variables for which historical trending will be applied, the sample rates and any criteria used to start and stop the historical trending.
  5. Wiring diagrams.
  6. System Schematics: Include systems furnished by others that are integrated into the DDC system.



7. Logic Schematics:
    - a. Provide for each system and subsystem a complete logic schematic indicating all inputs, outputs, decisions, etc.
    - b. Provide schematic format which includes all of the elements defined above.
    - c. Provide a legend for all symbols used.
  8. Information of a general, non-project specific nature is not acceptable.
  9. Start-up Testing Plan: Submit a start-up testing plan for each unique system.
    - a. The purpose of a start-up test is to demonstrate the "completeness" of the physical tasks associated with installation and the physical performance of the components.
- D. Submittals After Construction:
1. Start-up Testing Report.
    - a. Start-up testing reports shall be submitted on a per system basis.
    - b. Start-up testing reports shall be the documented results of the executed start-up testing plans.
  2. Operating and Maintenance Instructions: For all system components requiring maintenance include all maintenance information as required in Division 01 Section "Submittal Procedures" in addition to the following:
    - a. Descriptive System Information: Include system logic schematics, input/output functions and Sequences of Operation.
    - b. Operating Instructions: Include schedules and procedures for starting, stopping, cleaning, protection, testing, adjustments, calibration and replacement of components.
  3. As-Built Documentation:
    - a. Upon completion of the installation, and prior to acceptance by the Owner's representative, HI&C Contractor shall furnish as-built documentation and should include, but is not limited to the following:
      - 1) Points list in accordance with processor.
      - 2) Process flow diagram.
      - 3) Location plans.
      - 4) Operating sequences.
    - b. All changes to the above submitted drawings, equipment descriptions and operation manuals shall be clearly identified on the as-built documentation.
  4. Software:
    - a. Submit a copy of all software installed on the servers and workstations.
    - b. Submit all licensing information for all software installed on the servers and workstations.
    - c. Submit a copy of all software used to execute the project even if the software was not installed on the servers and workstations.
    - d. Submit all licensing information for all of the software used to execute the project.
    - e. All software revisions shall be as installed at the time of the system acceptance.
  5. Firmware Files:
    - a. Submit a copy of all firmware files that were downloaded to or pre-installed on any devices installed as part of this project.
      - 1) This does not apply to firmware that is permanently burned on a chip at the factory and can only be replaced by replacing the chip.
    - b. Submit a copy of all application files that were created during the execution of the project.
    - c. Submit a copy of all graphic page files created during the execution of the project.
    - d. Submit a copy of all secondary graphic files such as bitmaps, jpegs, etc. that were used in the creation of the graphic pages.

## 1.8 QUALITY ASSURANCE

- A. Fabrication, Programming, and Installation Personnel Qualifications:
1. Trained and experienced in the fabrication and installation of the materials and equipment.
  2. Knowledgeable of the design and the reviewed Shop Drawings.
  3. 3 years minimum experience in the design and installation of HI&C work similar to that specified herein.
  4. Have a field office within 150 miles of Owner's installation staffed with factory-trained personnel capable of routine maintenance and emergency service.

- B. Pre-Approved Installers: The following organizations are acceptable and are considered to meet the qualification requirements of this project:
  - 1. Grand Valley Automation, Grandville, Michigan.
  - 2. Control NET, LLC, Warren, Michigan.
  - 3. Trane, Livonia, Michigan.
  - 4. Automated Energy Systems, Madison Heights, Michigan.
  
- C. Regulatory Agencies Requirements:
  - 1. All temperature control wiring shall comply with NEC.
  - 2. All pneumatic piping installation shall comply with all state and local codes and ordinances.
  - 3. All smoke detectors shall bear the UL label and be FM approved.
  - 4. All components used for smoke control shall comply with UL864.
  - 5. All DDC I/O Devices (Specified and Future):
    - a. ASCII (American Standard Code for Information Interchange) coded.
    - b. Furnished with EIA (Electronic Industries Association) interface hardware.
  - 6. All instrumentation hardware shall be ISA (Instrument Society of America) compatible.
  - 7. All primary components of DDC hardware shall be UL listed (UL916).
  - 8. Installation shall comply with FCC (Federal Communications Commission) rules for Class A and Class B computing devices pursuant to Subpart J of Part 15.
  - 9. ASHRAE Standard 135, BACnet/IP.
  - 10. Network wiring shall comply with EIA/TIA Standards.

#### 1.9 WARRANTY

- A. In addition to the warranty provisions defined in the General Conditions, provide an extended warranty of a minimum 1 additional year (2 years total).

#### 1.10 SERVICE AGREEMENT

- A. Provide 12-month service and maintenance contract paid in full:
  - 1. Within 30 days after Substantial Completion.
  - 2. Signed by Manufacturer's authorized representative.
  
- B. Programming and Setpoint Adjustments:
  - 1. In addition to service and maintenance, include time for adjustments in setpoints, reset schedules, and sequence revisions as directed by the Owner to "fine tune" control systems to building and occupant characteristics through 1 year of seasonal changes under full operation.
  - 2. Documentation:
    - a. Submit documentation of actual time spent for programming and setpoint adjustments within 30 days after completion of the work for approval by Owner or Engineer.
    - b. Time spent for service and maintenance as included above is not part of this allotment and is to be documented separately.

#### 1.11 OWNERSHIP OF PROPRIETARY MATERIAL

- A. The Owner shall retain all rights to software for this project.
  
- B. The Owner shall sign a copy of the Manufacturer's standard software and firmware licensing agreement as a condition of this Contract. Such license shall grant use of all programs and application software to the Owner as defined by the Manufacturer's license agreement, but shall protect the Manufacturer's rights to disclosure of trade secrets contained within such software.
  
- C. The licensing agreement shall not preclude the use of the software by individuals under contract to the Owner for commissioning, servicing or altering the system in the future. Use of the software by individuals under contract to the Owner shall be restricted to use only for the purpose of commissioning, servicing or altering the installed system.

- D. All project developed software, files and documentation shall become the property of the Owner. These include but are not limited to:
1. Server and workstation software.
  2. Application programming tools.
  3. Configuration tools.
  4. Addressing tools.
  5. Application files.
  6. Configuration files.
  7. Graphic files.
  8. Report files.
  9. Graphic symbol libraries.
  10. All documentation.

## PART 2 - PRODUCTS

### 2.1 GENERAL REQUIREMENTS

#### A. General:

1. Provide a micro-processor based logic system using low voltage electricity as a communication medium with an open architecture and distributed intelligence. The system shall use Tridium as its platform.
2. All controlled components, sensors and controllers shall be addressable except:
  - a. Terminal heating units such as unit heaters, cabinet heaters, convectors, finned tube.
  - b. Ventilation fan and damper systems serving a single room and moving 1,000 cfm or less.
3. Provide completely computerized system using low voltage electricity as the operating medium.
4. System Functions:
  - a. Digital operation in accordance with preprogrammed strategies to control temperatures, energy use and selected electrical/mechanical equipment.
  - b. Capable of mathematical computation and logical/relational functions as required to achieve specified control strategies.
  - c. Capable of off-loading programs and accumulated data to magnetic media and a web browser.
  - d. Provide battery-powered RAM devices for program storage.
  - e. Continuous self-checking capability.
  - f. English language message display for all alarm and fault conditions.

#### B. Interoperability:

1. The system specified herein is a peer-to-peer addressable, standalone distributed control system integrating ANSI/ASHRAE Standard 135 (BACnet) technology and communication protocols in a common interoperable system. The system shall allow future expansion and modifications to the system with complete addressability without the use of proprietary components or software.
2. All software and intelligent devices shall comply with BACnet standards to provide complete interoperability between all system components.
  - a. Each BACnet device shall be furnished with a protocol information conformance statement (PICS) certifying compliance to a minimum of Level 3.
3. System shall provide complete password-protected accessibility to all devices, controllers and data using Java enabled web browsers without the requirement for proprietary software.

#### C. System Architecture:

1. The system architecture shall consist of 2 layers, the LAN layer and the field bus layer.
2. The TCP/IP layer connects all of the buildings on a single-wide area network (WAN) isolated behind the Owner's firewall. Fixed IP addresses for connections to the Owner's WAN shall be used for each device that connects to the WAN.
3. The IP architecture shall operate over multiple IT subnets.
4. Where multiple IT subnets are involved, a BACnet Broadcast Management Device (BBMD) shall be part of the system architecture within each IP subnet. The BBMD functionality shall be in a stand alone device or integral with a BACnet Building Controller.
5. The system architecture shall include a BACnet Building Controller (B-BC) to connect each field bus to the WAN.
6. Each field bus shall consist of multiple segments with no more than 125 total connected devices. Each segment shall be isolated from the other segments by a repeater. Each segment shall have no more than 30 connected devices.

- D. Networking:
1. All devices that connect to the LAN/WAN shall be capable of operating at 10 megabits per second or 100 megabits per second.
  2. LAN/WAN To Field Bus Routing Devices:
    - a. A BACnet Building Controller shall be used to provide this functionality.
    - b. These devices shall be configurable locally with RS232 or IP crossover cable and configurable via the LAN/WAN.
    - c. The routing configuration shall be such that only data packets from the field bus devices that need to travel over the LAN/WAN level of the architecture are to be forwarded.

## 2.2 MANUFACTURERS:

- A. Subject to compliance with interoperability requirements and these Specifications, hardware, software, and components shall be supplied by and bear the name of 1 or more of Manufacturers listed below. Alternate Manufacturers are also listed in this Specification for individual components.
- B. Acceptable Manufacturers:
1. Tridium.
- C. Stocking Requirements: All valves, operators, standard electrical components, and other replaceable parts shall be normally stocked within a 100 mile radius of the job Site.
- D. Electrical Components: Provide electrical components as specified in Division 26 and as manufactured by the acceptable Manufacturers listed therein.

## 2.3 HARDWARE SYSTEM REQUIREMENTS

- A. System Architecture:
1. Provide hardware comprised of a local building level primary controller and local control modules.
  2. User programmable.
  3. Provide Communication Networks:
    - a. Local links for distributed programming, data interchange and control at all system levels.
  4. Standalone capability for local control modules.
  5. Analog Input:
    - a. Analog sensing elements for remote indication to be independent of local sensors used for local control loops.
    - b. The A/D conversion resolution shall not exceed 0.01 volts per count.
  6. Binary Input:
    - a. Air flow status for each fan shall be indicated by means of a differential pressure sensing device which opens an electrical contact as the differential pressure falls below an adjustable pressure range setting.
  7. Output Control:
    - a. Provide the necessary relays and wiring required to start and stop points, specified on the point list, through their respective existing control circuit.
    - b. Wiring required to complement the following control functions:
      - 1) Auto: In the auto control, the existing control sequence is not changed.
      - 2) Close: In the close control, the controlled device is maintained in the fully closed position.
- B. System Features:
1. Modular construction and interoperable protocol to ensure future expansion capability with interconnection of system modules.
  2. Software configurable input and output points.
  3. Expandable Point Capacity:
    - a. At any point along the network without hardwiring points back to a central control panel.
    - b. Provide a minimum of 10% spare outputs user configurable for digital or analog.
    - c. System shall be modularly expandable to at least twice the installed capacity using additional hardware.

- C. System Communication:
1. High Speed LAN and/or WAN Based, Arcnet or Ethernet Compatible: Capacity for a minimum of 2 operator stations, allowing concurrent multiuser, multitasking access to DDC network and control units.
  2. Provide transparent peer-to-peer communication between all control panels.
  3. Support an Internet communication link utilizing standard Internet protocol.
- D. Operator Interface:
1. Provide fully programmable remote web based capabilities allowing alarm management and setpoint and schedule adjustments.
    - a. User interface shall be graphical in accordance with requirements below.
  2. Building Level Processor:
    - a. Run and print reports on specific equipment including AHUs, pumps, terminal units, boilers, etc.
    - b. Monitor and edit equipment scheduling parameters.
    - c. Receive and monitor alarms.
    - d. Exchange data (read and edit) between all the various control panels.
    - e. Receive and send data such that, from an off Site work station, all the functions listed under Items a, b, c, and d above, can be performed without the addition of new hardware or software.
  3. At Local Control Modules:
    - a. Peer-to-Peer Communications:
      - 1) Through an operator interface device, such as a laptop, hand held computer or touch pad screen, transparent interfacing to all other control panels shall be achieved such that it shall be as if being connected to the other control panel itself, without having to set up any separate communication services.
      - 2) Data, status information, reports, system software, custom programs, sensor data, etc., for all controllers shall be available for viewing and editing purposes.
    - b. Any Manufacturer's HVAC equipment using BACNet control and communication protocol provided with it, could be installed and connected at any time to the control panel system and transparently provide all sequence of operation controlling points and alarms, as if it came with the central control system's brand name controls on it, without having to add additional equipment.
    - c. Additional input and output points can be conveniently added via adding expansion modules.
  4. Application Software (latest versions reside on microcomputer):
    - a. Input/output capability from operator station.
    - b. System access level via software password.
    - c. Database creation and support.
    - d. Dynamic color graphic displays.
    - e. Alarm processing.
    - f. Event processing.
    - g. Data collection.
    - h. Full building graphics development.
    - i. Maintenance management.
    - j. Control software.
    - k. Report writing.
    - l. Trending applications.
    - m. Control Manufacturer's internet website server link.
- E. Primary Controller:
1. Features:
    - a. Building-level control system, with on-board storage of programs and data, and with monitoring capabilities over all points in the building system.
    - b. Capable of standalone operation, supervising local control modules without a host computer.
    - c. Built-in, password-protected, multi-function keypad/display providing complete access to building-level monitoring and control.
    - d. RS-232-C port for connecting an optional ASCII terminal and/or printer to supplement the built-in keypad/display terminal.
    - e. Equipped with multiple processors, battery backup of RAM, and a battery backed-up real time clock.

2. Functions:
    - a. Supervise all necessary building and energy management functions programs, including global data distribution (phase/power loss, outdoor temperature, external alarm status), time-of-day scheduling, holiday scheduling, optimized start/stop, duty cycle control, demand control, run time logging, equipment and system alarm monitoring, and self-diagnostics.
    - b. Network of local control modules (up to 256 input/output control points).
- F. Secondary Controller :
1. General:
    - a. Provide input/output, electronic thermostat, and terminal box controller modules as indicated on the Drawings and as required to satisfy the functional intent description of this Section.
    - b. Microprocessor-based with on-board program storage.
    - c. Capable of functioning as the input/output interface between the system and the building/equipment environment, providing control and management functions as programmed.
    - d. Capable of built-in bi-directional communication capability, over 2-wire cable or Ethernet, with the Primary Processor for programming and reporting functions and for supervision of all control and energy management operations.
    - e. Standalone capability to maintain programmed local control functions and operations including direct digital control in the event communications with the Primary Processor are lost.
    - f. Equipped with timed override switches to allow programmed off-hours operation.
    - g. Provide with LED indicators or LCD display to show schedule status, output status and communication status.
  2. Input/Output Modules:
    - a. Capable of the following local control capabilities:
      - 1) Supervisory and closed loop control.
      - 2) Setpoint and setback control.
      - 3) Positioning control.
      - 4) Proportional reset.
      - 5) Status monitoring.
      - 6) Equipment alarms.
      - 7) Sequencing (staging).
    - b. Local parameters and settings shall be monitorable and modifiable through the Primary Processor keypad/display terminal.
    - c. Perform energy and building management functions under supervisory control from the Primary Processor.
    - d. After initial communication with the Primary Processor, standalone programmed capabilities shall be stored on-board, in memory with 2,000 hour battery backup.
    - e. Equipped with 8 inputs and 8 outputs which shall be software configurable as either analog, digital or pulsed digital.
    - f. Configuration:
      - 1) Inputs and outputs shall be surge and spike protected.
      - 2) Inputs shall employ noise immunity circuits.
      - 3) Outputs shall employ noise suppression circuits.
      - 4) Outputs shall be equipped with internal manual/auto selection capability for local maintenance and troubleshooting use.
      - 5) Provide suitable intermediate devices where the load being controlled exceeds the rating of the output, or uses a different operating medium.
  3. Electronic Thermostat Modules:
    - a. Provide modules capable of the following:
      - 1) All necessary programmed functions.
      - 2) Energy and building management.
      - 3) Local control and monitoring.
    - b. Features Required:
      - 1) Automatic downloading by Primary Processor.
      - 2) Standalone operation after initial Primary Processor communication.
      - 3) RAM memory storage for failsafe, fixed setpoint program items.
      - 4) Permanent ROM memory storage for failsafe, fixed setpoint program items.
    - c. Local control functions include, but are not necessarily limited to:
      - 1) Cooling sequencing.
      - 2) Heating sequencing.
      - 3) Scheduling.

- 4) Fan on/off.
      - 5) Mixed air damper modulation.
      - 6) Temperature setback.
      - 7) Optimized start and stop.
      - 8) Timed override.
    - d. Provide for input device signal interface:
      - 1) Temperature Sensor: 4-20 mA.
      - 2) Air flow switch.
      - 3) Override pushbutton.
  4. Terminal Box Controller Modules:
    - a. Provide modules capable of the following:
      - 1) All necessary programmed functions.
      - 2) Energy and building management.
      - 3) Local control and monitoring.
      - 4) Integrating Primary Processor functions into local programs.
    - b. Features Required:
      - 1) Automatic downloading by Primary Processor.
      - 2) Standalone operation after initial Primary Processor communication.
      - 3) RAM memory storage for failsafe, fixed setpoint program items.
      - 4) Permanent ROM memory storage for failsafe, fixed setpoint program items.
    - c. Local control functions include, but are not necessarily limited to:
      - 1) Damper positioning.
      - 2) Fan start/stop.
      - 3) Reheat coil modulation.
      - 4) Temperature setback.
      - 5) Timed override.
    - d. Provide for input device signal interface:
      - 1) Temperature Sensor: 4-20 mA.
      - 2) Air flow switch.
      - 3) Override pushbutton.
- G. Rooftop Unit Controls:
  1. Provide rooftop unit controller modules as indicated on the Drawings and as required to satisfy the functional intent description of this Section. Coordinate with rooftop unit manufacturer on proposed interface.
    - a. Microprocessor based with on-board program storage.
    - b. Capable of functioning as the input/output interface between the system and the building/equipment environment, providing control and management functions as programmed.
    - c. Capable of built-in bi-directional communication capability, over 2-wire cable, with the Primary Processor for programming and reporting functions and for supervision of all control and energy management operations.
    - d. Standalone capability to maintain programmed local control functions and operations including direct digital control, in the event communications with the Primary Processor are lost.
    - e. Equipped with timed override switches to allow programmed off hours operation.
    - f. The DDC system control panel shall be capable of communicating with each individual rooftop and monitoring various points. There shall be 1 controller per rooftop that communicates back to the main control panel.
  2. The RTU controller shall be capable of monitoring and communicating the following information back to the system control panel:
    - a. Analog Input Points:
      - 1) Outdoor air temperature.
      - 2) Supply air temperature.
      - 3) Space air temperature.
      - 4) Return air temperature.
      - 5) Active setpoint.
      - 6) Outdoor air relative humidity (%).
      - 7) Space air relative humidity (%).
      - 8) Outdoor air damper position.
      - 9) Return air damper position.
      - 10) Space carbon dioxide level.

- b. Binary Input Points:
  - 1) Smoke/fire alarm status.
  - 2) Heating status.
  - 3) Economizer enable/disable status.
  - 4) Hot condenser gas reheat, coil enable/disable status.
  - 5) Supply fan on/off status.
  - 6) Supply fan failure.
  - 7) Exhaust fan on/off status.
  - 8) Exhaust fan failure.
  - 9) Cooling contactor status.
- 3. The system control panel shall provide the following control functions for each RTU:
  - a. Schedule all RTUs for heating night setback.
  - b. Schedule all RTUs for a heating morning warm-up.
  - c. Schedule night setup during cooling.
  - d. Schedule all RTUs for optimum start and provide a program that automatically adjusts on a daily basis the morning start-up time based on the zone temperature versus the occupied setpoint and the historical recovery rate for each unit.
- 4. Remote Sensors:
  - a. Air Temperature Sensor Quantity:
    - 1) See location detail on the Drawings.
  - b. Sensors shall provide input to the RTU controllers.
  - c. Sensors shall be located as indicated on the Drawings.

## 2.4 SOFTWARE SYSTEM FEATURES

- A. The programmable energy and building management functions include, but are not necessarily limited to:
  - 1. User Setpoint Control:
    - a. Time Of Day Scheduling:
      - 1) Capable of optimally starting based on individual unit recovery ramps.
      - 2) Time of day scheduling shall be continuous, such that if power is lost, on power up, the panel will look back for each device to see whether it should be on/off or in occupied/unoccupied temperature setpoints.
    - b. Holiday and weekend schedules.
    - c. Space temperature setpoint control.
    - d. Space humidity setpoint control.
    - e. Space ventilation setpoint control.
    - f. Timed Override:
      - 1) Each scheduled device shall be able to be overridden at the space sensor to the occupied mode for up to 4 hours.
      - 2) The override shall also be cancelable from the operator work station at any time during the override.
  - 2. System Controller Features:
    - a. Temperature reset.
    - b. Economizer control (free cooling).
    - c. Temperature control.
    - d. Humidity control.
    - e. Terminal box grouping.
    - f. Power fail restart sequencing.
    - g. PID loop control.
    - h. Data logging.
    - i. Duty cycling.
    - j. Optimized start/stop.
    - k. Demand limit control.
    - l. Control to greatest demand, with the ability to ignore specific demand inputs.
    - m. Event Log: The last 100 events shall be maintained for review at the OWS and remotely.
    - n. Daylight Savings Time:
      - 1) The system panel software shall automatically update time according to daylight savings at the legislated time and date, and reset time at the end of the daylight savings period.
      - 2) This function shall be able to be disabled.



3. Control programs include, but are not necessarily limited to:
    - a. Setpoint (closed loop).
    - b. Proportional reset.
    - c. Sequencing by time and/or temperature.
    - d. Limit and status monitoring.
    - e. Local emergency overrides.
    - f. Local timed schedule overrides.
    - g. Outdoor temperature operating limits.
  4. Capable of combining functions as required for specific user requirements.
- B. User and Programmer Access:
1. User password protected.
  2. Programmer password protected.
- C. Custom Programming:
1. Provide a user-friendly, interactive, "on-line" programming language for the purpose of creating custom programs for specific, unique applications.
  2. All custom programming must be performed in English language commands, and all inputs, outputs, variables and flags shall be addressable by user specific English names without requiring alphanumeric addresses or point numbers.
  3. The system shall be programmable to allow or secure each of the above setpoint controls at each level.
  4. Provide software graphic package, including graphical representations for all major systems:
    - a. Air handling units.
- D. Logs/Alarms:
1. Provide automatic logging of control alarms, critical alarms, kW demand history and kWh consumption.
  2. Additional logging shall be programmable including, but not limited to:
    - a. Equipment run time.
    - b. Historic trends and logs.
    - c. User defined meters.
    - d. User access logs and point scans.
  3. Provide alarm monitoring and reporting capabilities for all input points, including phase loss alarms, external alarms, load control alarms, critical alarms with auto-dial-up feature, alarm summary on printer, including time and date of alarm, and programmable power-failure restart sequence.
  4. Audible Alarms:
    - a. Provide audible alarm at building level processor for each alarm condition.
    - b. Provide operator silencing. Reset daily.
  5. At Control Panel Systems:
    - a. Peer-To-Peer Communications:
      - 1) Through an operator interface device, such as a laptop, hand held computer or touch pad screen, transparent interfacing to all other control panels shall be achieved such that it shall be as if being connected to the other control panel itself, without having to set up any separate communication services.
      - 2) Data, status information, reports, system software, custom programs, sensor data, etc., for all controllers shall be available for viewing and editing purposes.
    - b. Any Manufacturer's HVAC equipment using BACNet control and communication protocol provided with it, could be installed and connected at any time to the control panel system and transparently provide all sequence of operation controlling points and alarms, as if it came with the central control system's brand name controls on it, without having to add additional equipment.
    - c. Additional input and output points can be conveniently added via adding expansion modules.
    - d. Run and print trends of selected equipment performance characteristics in table and graph forms.
    - e. Run and print reports on specific equipment including RT U's, terminal units, etc.
    - f. Monitor and edit equipment scheduling parameters.
    - g. Receive and monitor alarms.
    - h. Manage the network including monitoring of the loss of communication and clock setting functions.
    - i. Exchange data (read and edit) between all the various control panels.
    - j. Receive and send data such that from another control Manufacturer's PC work station off Site from the primary head end, all the functions listed under Items a, b, c, d, e and f, above, can be performed without the addition of new hardware or software.

- E. Program Descriptions:
1. Time-Of-Day Scheduling:
    - a. Decrease energy consumption by turning off loads during unoccupied hours or unoccupied days.
    - b. Programmable in 1 minute increments.
    - c. Up to 64 discrete schedules in accordance with Primary Processor system.
    - d. Up to 16 groups of loads (consisting of up to 16 loads each) for concurrent scheduling.
    - e. Ability to assign loads to existing alternate schedules by linking.
    - f. Timed overrides and temporary "today" and "tomorrow" schedules, for each schedule.
  2. Setpoint/Setback Control:
    - a. Decrease energy consumption by modifying space temperature setpoints during scheduled unoccupied hours, thereby reducing use of mechanical heating or cooling.
    - b. Timed override off hours setpoint operation.
  3. Optimized Start/Stop:
    - a. Decrease energy consumption by learning building response to changing weather and automatically turning on HVAC as late as possible in the morning and off as early as possible in the evening, while meeting ambient temperature requirements during occupied hours.
    - b. Optimized start and stop times updated daily.
  4. Holiday Scheduling:
    - a. Allow up to 16 holiday periods to be programmed.
    - b. Each holiday period programmable for a maximum of 99 consecutive days.
  5. Duty Cycle Control:
    - a. Decrease kWh consumption by shedding and restoring electrical loads on a cyclic basis to reduce total on time.
    - b. Programmable cycle interval and on time.
    - c. Minimum off and on times to prevent damage to equipment.
    - d. Demand peak limit on initial start by staggered on times.
  6. Temperature Reset:
    - a. Capable of user-defined linear proportional reset functions.
    - b. Programmable reset parameters, variables and limits.
    - c. Variables programmable as the highest, lowest or average of multiple inputs.
  7. Economizer Control (Free Cooling):
    - a. Reduce energy consumption by utilizing outside air for cooling:
      - 1) Enthalpy based.
      - 2) In lieu of mechanical cooling equipment.
    - b. Programmable to operate fan systems during unoccupied hours of the cooling season in the maximum outside air mode.
  8. Direct Digital Temperature Control:
    - a. Maintain automatic temperature control directly by the local control module microprocessor.
    - b. Local module capable of performing all necessary local control functions.
  9. Terminal Box Grouping: The DDC shall be able to group VAV boxes via keyboard commands. These terminal unit groups shall make it possible to:
    - a. Send a common command to all boxes in a group to operate in the same mode.
    - b. Offset heating or cooling setpoints of 1 or more terminal unit groups by an adjustable amount.
    - c. Receive and display information on a group basis, including, but not necessarily limited to:
      - 1) Minimum group temperature.
      - 2) Maximum group temperature.
      - 3) Average group temperature.
      - 4) Current airflow through boxes in group.

## 2.5 ELECTRICAL DEVICES AND WIRING

- A. Comply with all local codes and applicable Sections in Division 26 of these Specifications.
- B. Low Voltage Wiring (24V or Less):
1. Installed in a ceiling plenum used for return air shall be plenum rated wire securely fastened in accordance with the requirements of Division 26.
  2. Exposed wiring shall be installed in accordance with the requirements of Division 26.

- C. Approved Manufacturers:
  - 1. Honeywell.
  - 2. Siemens.
  - 3. Allen-Bradley.
  - 4. GE.
  - 5. Square D.
- D. Limit Switches: Limit switches shall be oil tight type with appropriate operator to provide required function. Limit switches used on dampers should be set at approximately 75% of full stroke.
- E. Control Relays and Contactors:
  - 1. Relays shall be a minimum DPDT, of proper coil voltage, with indicator light, and of sufficient rating for specified purpose. Relay base shall be of the screwed terminal type.
  - 2. Contactors shall be definite purpose type, have adequate number of poles, of proper coil voltage, and of sufficient rating for specified purpose.
- F. Selector Switches:
  - 1. Switches shall be multiple position type, oil-tight, watertight, dust-tight, have the adequate number of contact blocks, capable of additional contact blocks, and of sufficient rating for specified purpose.
  - 2. Nomenclature plate shall be provided with appropriate wording, units, etc.
- G. Push Buttons and Pilot Lights
  - 1. Push button switches and pilot lights shall be, oil-tight, watertight, dust-tight, have the adequate number of contact blocks, capable of additional contact blocks, and of sufficient rating for specified purpose.
  - 2. Nomenclature plate shall be provided with appropriate wording, units, etc.
  - 3. Pilot lights shall be LED, push-to-test type with replaceable lamps and lens. Lens shall be of the appropriate color for application served.
- H. Environment:
  - 1. All devices shall be of the correct NEMA rating for the environment in which it is installed.
  - 2. Refer to Electrical Drawings for area classifications.

## 2.6 ELECTRIC INSTRUMENTS

- A. Thermistor Temperature Sensors and Transmitters:
  - 1. Accuracy:  $\pm 0.5$  degrees F at calibration point.
  - 2. Wire: Twisted, shielded pair cable.
  - 3. Insertion Elements in Ducts: Single point; use where not affected by temperature stratification or where ducts are smaller than 9 sf (0.84 sq. m).
  - 4. Averaging Elements in Ducts: Use where prone to temperature stratification or where ducts are larger than 10 sq. ft. (1 sq. m).
  - 5. Insertion Elements for Liquids: Brass or stainless-steel socket with minimum insertion length of 2-1/2 inches (64 mm).
  - 6. Room Sensor Cover Construction: Manufacturer's standard locking covers.
    - a. Setpoint Adjustment: Exposed.
    - b. Setpoint Indication: Exposed.
    - c. Thermometer: Exposed.
  - 7. Outside Air Sensors: Watertight inlet fitting, shielded from direct sunlight. Provide vandal resistant enclosures where accessible to the public.
- B. RTDs and Transmitters:
  - 1. Accuracy:  $\pm 0.2$  percent at calibration point.
  - 2. Wire: Twisted, shielded-pair cable.
  - 3. Insertion Elements in Ducts: Single point; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft. (0.84 sq. m).
  - 4. Averaging Elements in Ducts: Use where prone to temperature stratification or where ducts are larger than 9 sq. ft. (0.84 sq. m); length as required.
  - 5. Insertion Elements for Liquids: Brass socket with minimum insertion length of 2-1/2 inches (64 mm).

6. Room Sensor Cover Construction: Manufacturer's standard locking covers.
    - a. Setpoint Adjustment: Exposed.
    - b. Setpoint Indication: Exposed.
    - c. Thermometer: .
  7. Outside Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
- C. Low Temperature Detection:
1. Provide Electric Thermostat:
    - a. With 20-foot sensing element installed in a serpentine manner across the coil face area.
    - b. 2-position manual reset type with adjustable differential and of range to match the application.
  2. Provide multiple thermostats wired in series as required to provide complete coil area coverage.
  3. Shut down the unit supply fan upon detection of a low temperature along any 1-foot length of its sensing element.
- D. Static Pressure Transducer:
1. Factory installed and wired in the control box.
  2. The transducer shall have a range of 0 to 5-inch W.G. and shall have an accuracy of  $\pm 2\%$  of the range, including nonlinearity and hysteresis.
  3. The static pressure probe shall be field installed 2/3 down the duct or as indicated on the Drawings.
- E. Differential Air Pressure Switch:
1. The differential air pressure switch shall be factory installed across the supply fan inlet and discharge and field wired to the fan relay.
  2. The switch shall be SPDT and shall include a manual reset button.
  3. The switch shall be factory set and shall have the ability of being field adjusted over a range of 1.4-inch to 6.0-inch W.G.
- F. Relative Humidity Transmitter:
1. Polymer film capacitance change type.
  2. Temperature compensated.
  3. Accuracy:  $\pm 2\%$ .
  4. Range: 0 - 100% relative humidity.
  5. Ambient Temperature: 0 - 120 degrees F.
  6. Output Signal: 4 to 20 mA or 0 to 10 VDC, as required.
  7. Manufacturers:
    - a. General Eastern Instruments Corporation.
    - b. Vaisala, Inc.
- G. Dew Point Transmitter:
1. Saturated salt lithium chloride type.
  2. Accuracy:  $\pm 1$  degree F.
  3. Range: 12 to 99% relative humidity.
  4. Ambient Temperature: -40 to 140 degrees F.
  5. Input Power: 24 VDC or 115 VAC, as required.
  6. Manufacturers:
    - a. General Eastern Instruments Corporation.
    - b. Vaisala, Inc.
- H. Carbon Dioxide Sensor:
1. Manufacturer and Model: Johnson Controls, CDS-2000-2; or approved equal.
  2. Description: Carbon dioxide sensor using non-dispersive infrared (NDIR) sensing technology to measure carbon dioxide and provide a 1-10 VDC output signal corresponding to 2-2000 parts per million (ppm) concentration of carbon dioxide.
  3. Components:
    - a. Carbon dioxide sensor capable of measuring carbon dioxide concentration in air from 0-2000 ppm.
    - b. 24V AC transformer to power carbon dioxide sensor.
    - c. Supply air flow filter which inhibits sensing chamber contamination.
    - d. 2 front-mount wiring terminals blocks.

4. Performance Requirements:
  - a. Accuracy:  $\pm 100$  ppm carbon dioxide.
  - b. Repeatability:  $\pm 20$  ppm carbon dioxide.
  - c. Drift:  $\pm 100$  ppm carbon dioxide per year.
  - d. Response Time: Less than, or equal to 30 seconds maximum.
  - e. Airflow Rate: 500 milliliters per minute at 1.4 psi  $\pm 10\%$  through 1/4-inch O.D. tubing.

## 2.7 GAGES

- A. Air Pressure Gages:
  1. Provide 1-1/2-inch diameter gages at all input sensor lines, switch lines, branch side of each controller and at each controlled device.
  2. Stem or surface mounted as required.
  3. Compatible with tubing size.
- B. Temperature, Humidity and Pressure Indicators:
  1. Dial type having a minimum diameter of 3-1/2 inches, adjustable calibration, and accuracy of  $\pm 1/4\%$  of dial range.
  2. Thermometer ranges to match the range of the transmitter with which used.
  3. Furnish for all transmitters as described in the Functional Intent article of this Section.

## 2.8 AIRFLOW MEASURING STATIONS

- A. Pitot Tube Type:
  1. Manufacturers:
    - a. Air Monitor Corporation.
    - b. Cambridge Filter Corporation.
  2. Multi-pitot type with output signal based on equal area static pressure sensors.
  3. Accuracy of  $+2\%$  of air flow quantity.
  4. Designed for direct insertion in the duct system and of a configuration compatible with ductwork at installation point.
  5. Frame constructed of 16 gage minimum galvanized steel.
  6. Device shall include necessary velocity treatment and flow straightening devices to achieve stated accuracy.
  7. Provide permanent nameplate with the following information:
    - a. Manufacturer's name and address.
    - b. Unit size and serial number.
    - c. Design air flow, velocity and direction.
- B. Electronic Thermistor Type:
  1. Manufacturer: Ebtron.
  2. Hermetically sealed bead in glass thermistors.
  3. 304 stainless steel mounting brackets.
  4. Plenum rated cabling.
  5. Accuracy:  $\pm 2\%$  of reading at 0-5000 fpm.
  6. Repeatability:  $\pm 0.25\%$  of reading.
  7. 16 character LED display.
  8. Fully temperature compensated.
  9. Equal to Ebtron Gold series.
  10. Interface with central building automation system.
  11. Device shall include necessary velocity treatment and flow straightening devices to achieve stated accuracy.
- C. Thermal Dispersion Type:
  1. Manufacturer: NJK Precision.
  2. Anodized extruded aluminum dual chambered airfoil design.
  3. Inlet and outlet chambers consist of continuous apertures around the airflow station.
  4. The inlet chamber directs air through a mass thermal dispersion type airflow sensing module with microprocessor-based transmitter to produce an overall airflow rate.
  5. Fabricated to the required size that shall be field verified by contractor.

6. Install the airflow station and associated components according to the manufacturer's installation requirements.
7. The operating temperature range for all components of the station is from -25 degrees to 160 degrees F.
8. The sensing module for the airflow measuring station shall be mounted for maintenance accessibility and include a gasket to seal the measurement chamber from external airflow and moisture. Any access doors that may be required for maintenance shall be coordinated with the sheet metal installation contractor.
9. The sensor module will be provided by the same manufacturer as the airflow station. The number of sensor modules per airflow measuring station will be based on manufacturer's recommendation.
10. The sensor module shall be factory calibrated. Each sensor module shall be fully field serviceable without need for calibration.
11. Transmitter and Operator Interface:
  - a. The associated transmitter and operator interface shall include a high visibility, backlit, digital display. The display readout must indicate airflow volume in cubic feet per minute. The transmitter and operator interface shall be capable of being remotely mounted from the sensor module. The transmitter and operator interface shall be housed in a watertight casing.
  - b. Input power to the transmitter and operator interface shall be either 24VAC or 24VDC.
  - c. All transmitter and operator interface configuration, scaling, and diagnostic functions shall be performed by means of cover mounted keypad.
  - d. In cases where more than 1 airflow measuring station is required, the transmitter and operator interface must be capable of receiving input and displaying air volume from up to 8 airflow measuring stations subject to any wiring length limitations for the transmitter and sensor modules. Manufacturer's guidance on wiring length limitations shall be followed.
  - e. Transmitter outputs to a building automation system shall be analog (1-10VDC) representing the range of airflow volume. Where multiple airflow stations are being read by a single transmitter, there shall be 4 analog (1-10VDC) outputs to a building automation system. The outputs can be single airflow station readings, a summation of a number of airflow station measurements (up to 3) or an average of a number of airflow measuring stations (up to 3).
  - f. With regard to outside air currents and other transient air movement applications, the transmitter sensor shall have the ability to time average a delivered output signal. The time averaging shall be adjustable from 15 to 120 seconds.
  - g. Coordinate cabling distance requirements and limitations with the installation contractor.
  - h. All connections will be RJ-45 waterproof connection and all wiring will be plenum rated 550 MHz 23 AWG CAT 6 cables.
12. The measured airflow volume shall have accuracy within  $\pm 2\%$  of the full scale throughout the velocity range of 0-3,000 fpm.
13. The airflow sensor shall have an operating range of 50 fpm to 3,000 fpm, with a NIST traceable accuracy of  $\pm 2\%$  of reading for direct air flow measurement.

## 2.9 AUTOMATIC CONTROL DAMPERS AND OPERATORS

- A. Furnish dampers in accordance with the requirements of Division 23 Section "Dampers."
- B. Damper Operators:
  1. General:
    - a. Sized for ample power to overcome friction of damper linkage and air pressure acting on the blades.
    - b. Capable of operating at varying rates of speed to correspond to the dictates of the controllers and variable load requirements.
    - c. The operator linkage arrangement shall be such as to permit normally open or normally closed positions of the dampers as required.
  2. Electronic Damper Actuators:
    - a. Direct coupled type designed for minimum 60,000 full stroke cycles at rated torque.
    - b. Coupling: V-belt and V-shaped, toothed cradle.
    - c. Overload Protection: Electronic overload or digital rotation sensing circuitry.
    - d. Fail Safe Operation: Mechanical, spring return mechanism. Provide external, manual gear release on non-spring return actuators.
    - e. Temperature Rating: -22 to +122 degrees F.

## 2.10 INSTRUMENT TEST HOLES

- A. Provide surface mounted, flanged test holes with removable caps and of sufficient length to extend beyond external duct insulation.
- B. Install at all control points in ductwork, including, but not necessarily limited to:
  - 1. Discharge air controllers.
  - 2. Return air controllers.
  - 3. Mixed air controllers.
  - 4. Pressure sensors.
  - 5. Limit thermostats.
  - 6. Temperature sensors.
- C. As manufactured by Ventfabrics, Inc.; Ventlock, Model 699; or equal.

## 2.11 CONTROL PANELS

- A. Located within mechanical equipment rooms.
- B. UL listed for line voltage system with removable face panel.
- C. Furnish in Manufacturer's standard color.
- D. Constructed and installed in accordance with Article 409 of the NEC (NFPA 70).

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Electrical Wiring:
  - 1. Motor Starters:
    - a. Provide independent control circuit to each motor starter contactor coil.
    - b. Provide a normally open interlock contact in each motor starter to indicate contactor status at DDC.
    - c. Provide one electrically separate, normally open contact to start or stop each motor controlled by the system.
  - 2. Limit Interlocks:
    - a. Wiring of limit interlocks and dampers shall include on-off-auto switch on speed controllers.
    - b. Wiring of all limit interlocks shall be such that the equipment will be de-energized in all operating positions of the starter.
  - 3. Provide separate branch circuits for all 120 VAC power serving DDC equipment and related components.
- B. Outside Air Transmitters:
  - 1. Locate on a north exterior wall.
  - 2. Do not locate in fresh air ducts.
- C. Duct Pressure Sensors:
  - 1. Locate and set duct static pressure sensors as indicated on the Drawings or as instructed by the Engineer.
  - 2. Allow for one relocation and one reset of each static pressure sensor as instructed by the Engineer at no additional cost to the Owner.

### 3.2 FIELD QUALITY CONTROL

#### A. Demonstration and Acceptance Test:

1. Operate each and every phase of the control system separately, or in conjunction one with the other:
  - a. For a sufficient period of time to demonstrate the ability of the system to meet performance requirements in accordance with the true intent and purpose of these Specifications.
  - b. Provide for notification and approval of Engineer as required by Division 01 Section "Starting and Adjusting."
2. The HI&C Subcontractor is responsible for verifying and demonstrating that each Sequence of Operation is being performed and design conditions stably maintained under operating conditions.
3. Acceptance of performance will be provided by the Engineer and CxA.
4. Provide 8 hours of field service time for demonstration and acceptance test. Additional costs required due to retesting due to failure of system to perform satisfactorily shall be the responsibility of HI&C Subcontractor.
5. Trend Logging:
  - a. Submit a 2 week log in graph form of inputs and outputs on a 1/2-hour basis. As indicated on the Table (included at end of this Section), a minimum of the following systems will be included:
  - b. Data is to be provided in an electronic spreadsheet or ASCII format on electronic media.
  - c. Submit trend data at start-up and also during cold and warm weather for the systems indicated on Table at the end of this Section:

#### B. Operator Instruction:

1. During system commissioning, and at such time acceptable performance of the system hardware and software has been established, provide onsite operator instruction to Owner's operating personnel.
2. Operator instruction during normal working hours shall be performed by competent Manufacturer's representative familiar with the software, hardware and accessories.
3. At a time mutually agreed upon during system commissioning as stated above, provide instruction to Owner's designated personnel on the operation of all equipment within the system and describe its intended use with respect to the programmed functions specified.
4. Includes, but is not necessarily limited to:
  - a. The overall operational program, equipment functions (both individually and a part of the total integrated system).
  - b. Commands.
  - c. Advisories.
  - d. The appropriate operator's intervention required in responding to the system's operation.
  - e. A description of the chronological information flow from field sensors, contacts and devices to the centrally located control console.
  - f. The overview of the system's communication network to acquaint the operator of the interplay between initiating devices, remote processing units, loop communications and their importance within the operating system.
5. Provide additional information time, as deemed necessary by Owner's authorized representative, on a negotiated basis with Owner.

#### C. Troubleshooting: Comply with the requirements of Division 23 Section "General HVAC Provisions," Article 1.7, for troubleshooting.

### 3.3 ADJUSTMENTS AND CALIBRATION

#### A. Upon completion of this Project, adjust and validate all thermostats, controllers, valves, damper operators, relays, and other components provided as part of the temperature control system.

#### B. Calibration:

1. After completion of installation, the pneumatic piping shall be tested for leaks.
2. Provide calibration documentation to Engineer, which shall include:
  - a. Airflow transmitter calibration curves to relate the transmitter output signal to the actual airflow as well as to the pressure drop across the primary flow measuring element.
  - b. For pressure, differential pressure, flow, and other transmitter's provide calibration curves using the zero, span and 3 other points between 10% and 90% of span. These curves shall relate the output signal of the transmitter to the primary measured value.



- c. Indicating instruments shall read true conditions and be checked with test instruments.
  - d. Calibration of temperature and humidity sensors.
- C. Adjustments, Tuning and Start-up:
- 1. After the completion of calibration, adjust and tune the controls.
  - 2. Provide documentation, which is to include:
    - a. Input/output relationship of all controllers, positioners, and final drive units.
    - b. Gains and time constants established in all controllers.
    - c. Loop setpoints.
    - d. Limits on control actions.
    - e. Alarm limits.
    - f. Control dead bands.
  - 3. Provide seasonal adjustments as required under Article 1.10 - Service Agreement.

PROVIDE THE FOLLOWING TRENDS IN GRAPH FORM:															
Control Systems	Trend with Cold Weather	Trend with Warm Weather	Supply Air Temp	Outdoor Air Temp	Controlled Setpoint	Distribution Supply Wtr Temp	Distribution Return Wtr Temp	Source Equip On-Off Cycles	Distribution Pumps On-Off Cycles	Controlled RH Level	Mixed Air Temp	Space Temp	Sensed Static Pressure Level	Damper or Valve Position	Speed Drive Output Level
RTU Economizer Cycle	X	X	X	X							X			X	
RTU Heating Coil	X		X	X							X			X	
RTU Cooling Coil		X	X	X							X			X	
VAV Terminals	X	X	X									X	X	X	
Duct Pressure Control	X	X			X								X		X
Duct Reheat Coils	X	X	X									X			

END OF SECTION 23 09 00

## SECTION 23 31 13 – METAL DUCTS

### 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. Refer to Division 23 Section “Hangers and Supports for HVAC Piping, Ductwork and Equipment” for ductwork and equipment.

#### 1.2 SUMMARY

- A. This Section includes the furnishing and installation of sheet metal ductwork, and appurtenances:
  - 1. As indicated on the Drawings.
  - 2. As specified herein.
  - 3. As required to provide a complete and operational air distribution system.
  - 4. As necessary for the proper and complete performance of the Work.
  - 5. Including all hangers, supports, and anchors.

#### 1.3 DESIGN AND PERFORMANCE REQUIREMENTS

- A. Provide all hangers, supports, braces, and connections in accordance with the guidelines of the SMACNA.
- B. Comply with the requirements of Division 23 Section “Sound and Vibration Control for HVAC” for vibration isolation of ductwork.

#### 1.4 REFERENCES

- A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with the following:
  - 1. ASHRAE Guidelines:
    - a. 2000 Handbook - Chapter 16 - "Duct Construction."
    - b. 2001 Handbook - Chapter 34 - "Duct Design."
    - c. ASHRAE 62.1, current version.
  - 2. ASTM Specifications:
    - a. A480 - General Requirements for Flat-Rolled Stainless Steel and Heat-Resisting Steel Plate, Sheet, and Strip.
    - b. A653 - Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
    - c. A924 - General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
    - d. B209 - Aluminum and Aluminum - Alloy Sheet and Plate.
  - 3. ASTM Standard Test Methods:
    - a. A90 - Weight of coating on Zinc-Coated (Galvanized) Iron or Steel Articles.
    - b. C731 - Extrudability, after Packaging, Aging, of Latex Sealants.
    - c. D2202 - Slump of Sealants.
  - 4. NFPA Standards:
    - a. 90A - Installation of Air Conditioning and Ventilating Systems.
    - b. 90B - Installation of Warm Air Heating and Air Conditioning Systems.
    - c. 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operation.
  - 5. SMACNA Guidelines:
    - a. "HVAC Duct Construction Standards, Metal and Flexible," 1985 Edition.
    - b. "Rectangular Industrial Duct Construction Standards."
    - c. "Round Industrial Duct Construction Standards."
    - d. "Guide for Steel Stack Construction."
  - 6. UL Standards: 181 - Factory Made Air Ducts and Connectors.

### 1.5 SYSTEM DESCRIPTION

- A. Duct sizes indicated on Drawings are net clear inside dimensions.
- B. Duct Construction Pressure Classifications:

	Duct System	SMACNA Pressure Classification
1.	Supply duct downstream of VAV terminals,	1" W.G.
2.	Supply duct upstream of VAV terminals	3" W.G.
3.	Return duct	1" W.G.
4.	Exhaust duct connected to fans	1" W.G.

### 1.6 SUBMITTALS

- A. Manufacturer's Data: Sequential parts list for each part.
  - 1. Name of Manufacturer.
  - 2. Part name and model number.
  - 3. Dimensions.
- B. Duct Pressure Test:
  - 1. Written procedure for leak testing installed supply, return, and exhaust ductwork system 30 days prior to testing.
  - 2. Duct pressure test report.

### 1.7 QUALITY ASSURANCE

- A. Fabrication and Installation Personnel Qualifications:
  - 1. Trained and experienced in the fabrication and installation of the materials and equipment.
  - 2. Knowledgeable of the design and the reviewed Shop Drawings.
- B. Regulatory Agencies Requirements:
  - 1. All state and local codes, and ordinances.
  - 2. Owner's insurer.
  - 3. Flexible ductwork shall comply with:
    - a. UL listed - Class 1 Air Duct Material, Standard 181.
    - b. NFPA Standard 90A - Flame spread: 25, Smoke developed: 50.

### 1.8 DELIVERY, STORAGE, AND HANDLING

- A. All materials shall be delivered in original, unbroken, brand marked containers or wrapping as applicable.
- B. Handle and store materials in a manner which will prevent deterioration or damage, contamination with foreign matter and damage by weather or elements in accordance with Manufacturer's directions.
- C. Reject damaged, deteriorated or contaminated material and immediately remove from the Site. Replace rejected materials with new materials at no additional cost to Owner.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Duct Connection Systems:
  - 1. Ductmate Industries, Inc.
  - 2. Lindab, Inc.

- B. Flexible Duct:
  - 1. JPL.
  - 2. ATCO.
  - 3. Thermaflex.
- C. Prefabricated Fittings:
  - 1. United McGill Corporation.
  - 2. Buckley Air Products, Inc.
  - 3. Eastern Sheet Metal, Inc.
  - 4. LaPine Metal Products.
  - 5. Lindab, Inc.
  - 6. Semco.
  - 7. Universal Spiral Air.
  - 8. Allied Mechanical Services
  - 9. Zinger Sheet Metal
- D. Manufactured ductwork and fittings shall be of one Manufacturer to ensure tight fit of ductwork and components.
- E. Manufacturer's Stamp:
  - 1. Manufacturer's stamp shall be on the outside of the ductwork.
  - 2. Stamp shall be clean and clear, indicating the metal gage.

## 2.2 MATERIALS

- A. Galvanized Steel:
  - 1. Galvanized steel of lock-forming quality with minimum ASTM A653, G90 zinc coating, both sides in accordance with ASTM A90.
  - 2. Use for all ductwork systems unless noted otherwise.
- B. Aluminum Alloy:
  - 1. Lock-forming quality complying with ASTM B209, Alloy No. 3003-H-14 minimum, or equivalent.
  - 2. One side bright finish where exposed to view.
  - 3. Mill finish where concealed.
- C. Acceptable Fasteners:
  - 1. Rivets, bolts, or sheet metal screws.
  - 2. Stainless steel.
- D. Tapes:
  - 1. High pressure rated, non-hardening, water resistant and fire-resistant.
  - 2. Compatible with duct material.
- E. Sealants:
  - 1. Fire and Smoke Hazard Rating:
    - a. As tested by ASTM E84, NFPA 255, or UL 723.
    - b. Not to exceed: Flame spread 25, smoke developed 50.
  - 2. Exterior Mastic Sealant: Certified to pass 600 hours QUV; or equivalent weather testing.
  - 3. Comply with ASTM C731 and D2202.
  - 4. Specifically formulated for sealing the field joints.
  - 5. UL listed.
  - 6. Hardcast, Inc., Iron Grip 601, Flex Grip 550, Duct Seal 321.
  - 7. 32-17 Safetee, 32-14 High Velocity Duct Sealant.
  - 8. Childer CP-146, Chil Flex C—147.
- F. Hangers:
  - 1. Galvanized steel band iron.
  - 2. Rolled angle and 3/8-inch minimum galvanized steel rod.

- G. Wall Supports:
  - 1. Galvanized steel band iron.
  - 2. Fabricated angle bracket.
- H. Vertical Supports at Floors:
  - 1. Rolled steel angle 1-1/2 x 1-1/2 x 1/8 minimum.
  - 2. Mechanically attached to duct.

## 2.3 FABRICATION

- A. General: Construct rectangular, round and flat oval ductwork, and fittings in accordance with the SMACNA HVAC Duct Construction Standards, Metal and Flexible, current edition.
- B. Round Ducts:
  - 1. 60-inch Diameter and Smaller: Spiral lockseam construction.
- C. Transitions: Make every change in size or shape of duct with taper not exceeding 20 degrees.
- D. Connections:
  - 1. Make connections to equipment as indicated on Drawings or called for by these Specifications.
  - 2. For rectangular connections, crimp fabric to sheet metal and fasten sheet metal to ducts by screws 2-inch on center.
  - 3. Flexible Ductwork Connections:
    - a. Securely fasten flexible duct to round sheet metal ducts or duct collars with stainless steel or zinc-coated iron draw bands with worm gear fastener.
    - b. Flexible duct 10-inch diameter or less, installed on 1-inch W.G. pressure classification duct may be attached with nylon cable ties.
    - c. Fabric shall not be stressed other than by air pressure.
- E. Elbows and Tees:
  - 1. Provide rectangular mitered elbows with acoustic turning vanes as indicated on the Drawings. Refer to Division 23 Section "Sound and Vibration Control for HVAC" for acoustic turning vanes.
  - 2. Where mitered elbows are not indicated on the Drawings: Maintain centerline radius of 1-1/2 times duct width in plane of turn.
- F. Turning Vanes and Distribution Devices: Where registers, grilles or diffusers are located less than 5 equivalent duct diameters from the main duct, provide necessary distribution grids or turning vanes to ensure even distribution of air over the entire face of the outlet.
- G. Obstructions:
  - 1. Wherever a pipe or other obstruction passes through a duct (this condition is to be avoided if possible), pass the obstacle through an airfoil sleeve in the duct.
  - 2. Increase duct area at the obstruction if more than 20% of duct area is displaced by obstruction.
  - 3. Streamline sleeve to maintain angles at duct size changes at 20 degree angle.
- H. Provide necessary plastering frames and drawbands required.
- I. Branch Ducts:
  - 1. Construct with full radius elbow turning into a transition section in the main duct.
  - 2. Provide with damper and quadrant as specified in Division 23 Section "Dampers."
- J. Mixing Boxes:
  - 1. Modify, by experimentation if necessary, the return and outdoor air mixing section of duct if nuisance tripping of freeze-stat occurs due to inadequate mixing of airstreams.
  - 2. Install sheet metal baffle plates to promote mixing and eliminate stratification.

## 2.4 MANUFACTURED UNITS

- A. Turning Vanes:
1. Hem the leading edge of vanes in ducts over 20-inch width with 1/2-inch fold-back.
  2. Reinforce turning vanes in ducts over 24-inch diameter with rods or sectional construction to limit unsupported length to 24 inches.
  3. 24 gage, minimum.
  4. Use in rectangular elbows with R/D ratio of less than 1.5.
  5. Double wall.
- B. Acoustic Turning Vanes: Refer to Division 23 Section "Sound and Vibration Control for HVAC."
- C. Bellmouth Fittings:
1. Use spun bellmouth connections at each round take-off from the high pressure plenum.
  2. Manufactured spun Bellmouth fittings may be used in lieu of take-offs indicated on Drawings: Buckley Air Products Type BM; or equal.
- D. Takeoffs from Round 1-inch Pressure Classification Duct:
1. Made with factory fabricated lateral type fittings.
  2. At an angle of no more than 45 degrees.
  3. As manufactured by United McGill Corp., Model SRL; or approved equal.
  4. In accordance with detail on Drawing.
- E. Flexible Duct:
1. Construction:
    - a. Liner of laminated aluminum foil/fiberglass/aluminated polyester.
    - b. Zinc-coated steel or aluminum helix bonded to liner.
    - c. Insulation R-value: 4.2.
    - d. Seamless copolymer vapor barrier jacket.
    - e. Rated for pressure class of system in which duct is used.
  2. Maximum flexible duct length shall not exceed 5 feet, maximum flex duct turn not to exceed 45 degrees.
- F. Manufactured Ductwork Connection Systems:
1. General:
    - a. In lieu of SMACNA Duct Construction Standards, Contractor may use an alternative engineered connection system such as Ductmate, "Spirosafe" by Lindab; or approved equal.
    - b. Designed to provide equivalent reinforcing and pressure characteristics.
  2. Description:
    - a. Duct, gasket, and fitting providing an airtight outer pressure shell.
    - b. The construction shall have mechanical means to maintain positive or negative pressure requirement, or both, and rigidity equivalent to SMACNA joints and metal gages.
  3. Duct Material:
    - a. Outer Shell: Galvanized steel.
    - b. Metal Gage: As required to meet pressure classification indicated.
  4. Gasket: Neoprene.
  5. Fittings:
    - a. As indicated on Drawing and of same Manufacturer as duct section.
    - b. Sized to slip fit into the duct sections, without sharp projections for noise and airflow disturbances.
- G. Round and Flat Oval, Internally Insulated Ductwork:
1. Description:
    - a. Duct and fitting comprised of an airtight outer pressure shell, a 1-inch insulation layer, and a perforated metal inner liner which completely covers the insulation throughout.
    - b. Fittings to have solid metal liner.
    - c. The construction shall have mechanical means to maintain positive concentricity of liner with shell and to retain insulation against dislocation by assembly processes.
    - d. United McGill Corp. Acousti-K27; or approved equal.
  2. Duct Material:
    - a. Outer Shell: Galvanized steel.
    - b. Inner Liner: Perforated galvanized steel.



- c. Metal Gage: As required to meet pressure classification indicated.
3. Insulation: Comply with the requirements of Division 23 Section "Sound and Vibration Control for HVAC" for internal duct liner.
4. Fittings:
  - a. As indicated on Drawing and of same Manufacturer as duct section.
  - b. Sized to slip fit into the insulated duct sections, without spaces for air erosion of insulation or sharp projections for noise and airflow disturbances.
  - c. Butt joints are not suitable for the inner liner of double wall duct.

## 2.5 SPECIAL CONSTRUCTION

- A. Metal casing housing and plenums for all fans, coils, humidifiers, filter, and other equipment shall be in accordance with SMACNA.
- B. Install 16 gage stainless steel drip pan under cooling coils with proper drains and fitting. Seal water tight.

## 2.6 DUCT ACCESS DOORS

- A. Manufacturers:
  1. Prefco.
  2. Pottorff.
  3. Ventfabrics, "Ventlock."
  4. Greenheck.
- B. Provide In Ductwork:
  1. As indicated on the Drawings.
  2. Wherever necessary for proper access to instruments, controls, fire dampers, motorized dampers, coils and equipment.
  3. For convenient inspection, maintenance and replacement.
  4. Reinforce openings on sides with material or ductwork in which doors are installed.
- C. Construction:
  1. Two-piece 22 gage minimum pan construction, consisting of outer side crimped over inner dished side.
  2. Continuous piano hinge and not less than 2 heavy cam latches. A removable type door is acceptable only where there is inadequate clearance for a hinged door.
  3. Contact surfaces of doors covered with heavy dense felt securely fastened in place to make doors air tight.
  4. Insulated or soundproofed with same materials as ducts or casings where located.
  5. Ruskin ADH22 or ADC22; or equal.

## 2.7 SOURCE QUALITY CONTROL

- A. Certified Testing:
  1. Suppliers of manufactured round and oval ductwork shall have on file with Engineer certified copies of test data made by an independent United States laboratory covering pipe and fittings as manufactured by that Supplier.
  2. Spiral Pipe Test Data:
    - a. Cover leakage rate, bursting strength, collapsing strength, seam strength and friction loss.
    - b. Friction loss test data shall cover both the duct and the assembled coupling joints.
    - c. This friction loss data shall be equal to or less than the friction loss data used in the design of this system.
  3. The fitting test data shall cover the friction loss tests of all fittings used on the project.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

#### A. General:

1. Install ductwork and accessories to provide a system free from buckling, warping, breathing, vibration, rattling, or whistling.
2. Lap ducts in direction of air flow with longitudinal seams locked and hammered tight.
3. Provide flat "S" cleats on all exposed traverse duct connections in finished areas.
4. Install ducts straight with building walls where possible and exposed duct tight against roof or walls where possible.
5. Ducts shall be air-tight, rigid, securely hung or bracketed in position.
6. At the end of an uninsulated section or run, where internally insulated duct connects to uninsulated spiral duct or fitting, fire damper or flex, install an insulation end fitting to bring the outer shell down to nominal size.
7. Install screws and rivets of such length that they do not interfere with the operation of manual or automatic dampers.
8. Provide 1-inch long metal nosing around entire duct perimeter at all exposed and leading edges of internal acoustic ductwork lining.

#### B. Protection of System:

1. Cap the ends of sheet metal ductwork, including the roof openings, registers and diffuser openings with temporary durable air-tight and water-tight covers during all stages of construction in order to keep system clean.
2. If permanent heating and cooling equipment is used prior to Substantial Completion, protection of ductwork systems shall comply with Division 01 Section "Temporary Facilities and Controls" and Division 23 Section "General HVAC Provisions."

#### C. Hanging Duct:

1. Allow swing in long direction of duct for movement.
2. Double nut hanger rods.

#### D. Duct Anchoring:

1. Galvanized sheet metal hanger straps attached to construction.
2. Angle metal screwed to the ductwork.

#### E. Turning Vanes:

1. Use in rectangular mitered elbows with R/D ratio of less than 1.5 and elsewhere as indicated.
2. Install evenly spaced along elbow diagonal with leading and trailing edges aligned to sides of duct.
3. Install vanes on 3-3/4-inch centers.
4. Elbows Where Duct Changes Size:
  - a. Mount vanes individually (not on premanufactured vane runners).
  - b. Ensure that leading and trailing edges align parallel to sides of duct.

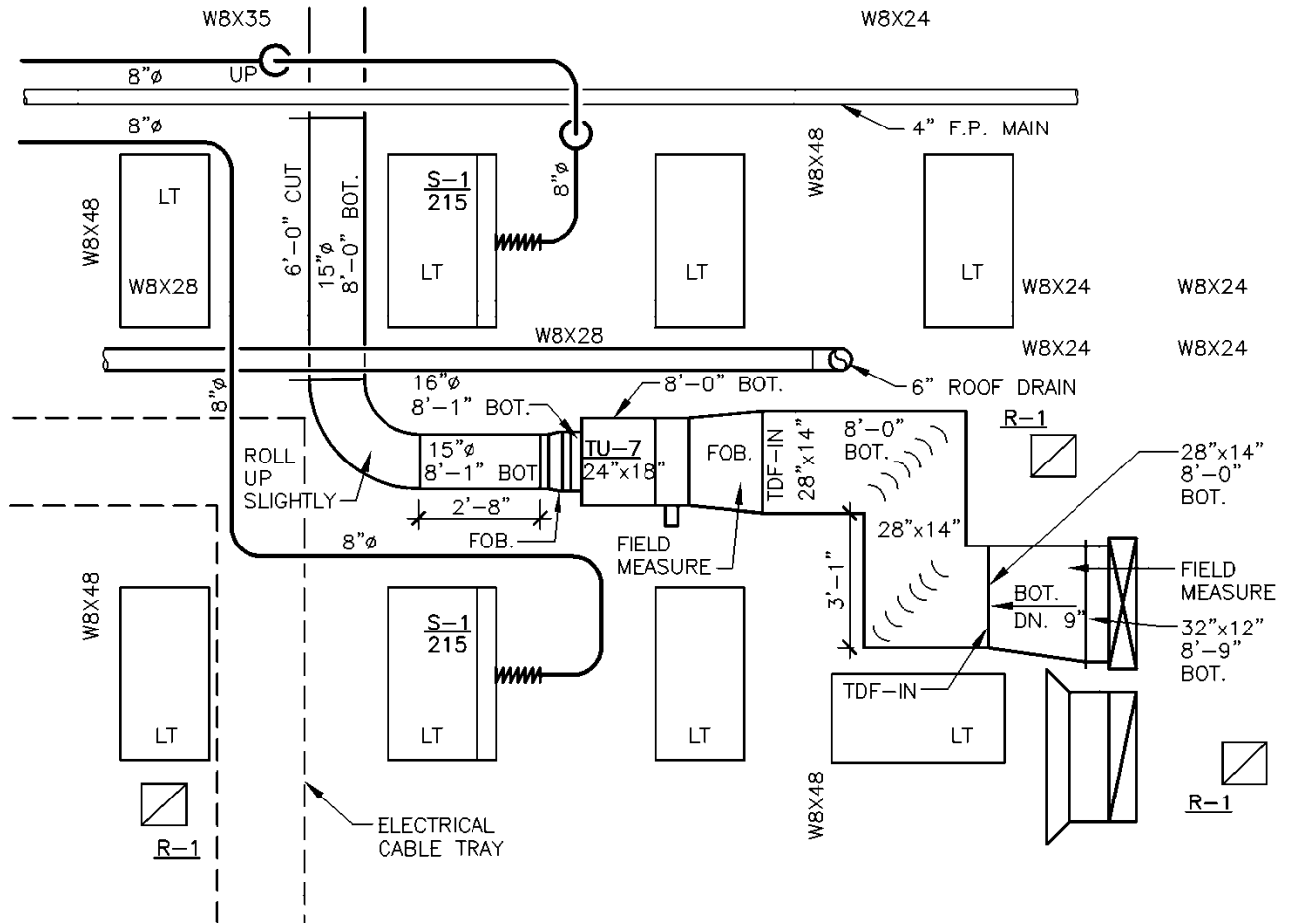
#### F. Exterior Ductwork: Refer to SMACNA Guidelines specified in Paragraph 1.3.A.5.a, Pages 5-6, 5-7, and 5-8 for requirements of construction and installation.

#### G. Joint Sealing of Duct Systems:

1. Except where using gasketed duct connection systems, seal ductwork in accordance with SMACNA Class A:
  - a. Seal ductwork including supply, return, mixed, outdoor, and exhaust air systems.
  - b. For Round and Flat Oval Ductwork:
    - 1) Apply approved sealant to the male end of the couplings and fittings.
    - 2) After the joint is slipped together, place sheet metal screws 1/2-inch from the joint bead for mechanical strength.
    - 3) Apply sealer to the outside of joints including longitudinal joints, extending 1-inch on each side of the joint.
    - 4) Cover screw heads.

- c. For Rectangular Ductwork:
        - 1) Apply approved sealant to transverse and longitudinal joints.
        - 2) Extend sealant a minimum of 1-inch on each side of joint.
      - d. Follow sealant Manufacturer's directions for application, storage and cure time.
      - e. Ductwork located outside shall be air and watertight.
      - f. Aluminum Ducts: Seal seams and joints watertight. Pitch ducts to low points and drain low points in the system.
    - 2. Manufactured Connection Systems:
      - a. Acceptable in accordance with Paragraph 2.1.
      - b. Seal flanged joints with neoprene gaskets.
  - H. Appearance: Where exposed ducts pass through walls or floors: Refer to Division 23 Section "Penetrations for HVAC."
- 3.2 SEALING AROUND LOW AND HIGH PRESSURE DUCT OPENINGS
- A. The openings around ducts that penetrate full height walls (defined as walls that extend from the floor to the structure above): Seal to maintain the acoustic integrity of the wall. This applies to all full height walls regardless of whether the wall has a fire rating.
  - B. Gaps:
    - 1. Less Than 1/2-inch Between Duct and Wall Opening: Pack with batt insulation and the exposure caulked on both sides of the wall.
    - 2. Gaps 1/2-inch and Larger Between Duct and Wall Opening: Pack with batt insulation and a sheet metal collar installed around the entire duct on both sides of the wall. Extend the sheet metal collar from the surface of the duct to a minimum 2 inches on the wall, and be secure to the wall.
- 3.3 HANGING AND SUPPORT
- A. All Ducts:
    - 1. Support in a secure manner.
    - 2. Subject to Engineer's approval.
  - B. In accordance with Chapters 5 and 6 of the SMACNA HVAC Duct Construction Standards.
  - C. Do not support ductwork from metal roof deck.
  - D. Remove and replace unacceptable work at no additional cost to Owner.
- 3.4 FIELD QUALITY CONTROL
- A. Duct Systems to be Tested:
    - 1. Supply ducts. Supply ducts upstream of VAV boxes.
    - 2. Return ducts.
    - 3. Exhaust ducts. Exhaust ducts connected to Fans.
  - B. Pressure Testing:
    - 1. Pressurize the installed duct system to a test pressure 50% over the designated SMACNA pressure classification.
    - 2. Measure air leakage at the test pressure by an orifice type of flow meter which has been individually calibrated against a primary standard and this calibrated curve permanently attached to the orifice tube assembly.
    - 3. If the system is tested in sections, add the leakage rates to give the performance of the whole system.
    - 4. Total allowable leakage of the system shall not exceed 1.0% of the air handling capacity of the system.
    - 5. Correct Objectionable Noise:
      - a. Even if the system passes the leakage rate criteria.
      - b. To the satisfaction of Engineer.
    - 6. Apply duct tape over sealed joints prior to testing, if the system is to be tested before the recommended sealer curing time has elapsed.

- C. Perform testing in accordance with a printed procedure reviewed by Engineer.
- D. Notify Engineer 1 week prior to duct pressure test to allow Engineer the option to be available to observe testing.
- E. Pressurization Control:
  - 1. Protection against duct overpressurization or underpressurization during testing is the responsibility of Contractor.
  - 2. Verify that control, variable air volume, balancing, and fire dampers are open.
  - 3. Verify that pressure relief panels or controls are operational.



END OF SECTION 23 31 13

## SECTION 23 33 13 – 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.

#### 1.2 SUMMARY

- A. This Section includes, but is not limited to, the major items listed below:
1. Fire dampers.
  2. Smoke dampers.
  3. Fire and smoke dampers.
  4. Airflow regulating dampers.
  5. Gravity backdraft dampers.
  6. Control dampers.
- B. Division of Work:
1. In accordance with the General Conditions, Contractor is responsible for dividing the Work among the Subcontractors and Suppliers and for delineating the Work to be performed by specific trades.
  2. The following are suggestions as to how the Work may be divided. This is not a complete list of all the Work:
    - a. Mechanical Subcontractor:
      - 1) Install control dampers.
      - 2) Provide manual dampers and gravity backdraft dampers.
    - b. Temperature Control Subcontractor:
      - 1) Furnish control dampers, linkages and operators unless specifically noted otherwise on Drawings.
      - 2) Install linkages and operators on dampers.

#### 1.3 REFERENCES

- A. Except as herein specified or as indicated on the Drawings, the Work of this Section shall comply with the following:
1. NFPA 90A - Air Conditioning and Ventilating Systems.
  2. SMACNA Publications:
    - a. Fire, Smoke and Radiation Damper Installation Guide for HVAC systems.
    - b. HVAC Duct Construction Standards - Metal and Flexible.
  3. ASTM:
    - a. E84 - Test for Surface Burning Characteristics of Building Materials.
    - b. E477 - Test Method for Measuring Acoustical and Airflow Performance of Duct Liner Materials and Prefabricated Silencers.
  4. UL:
    - a. 555 - Fire Dampers.
    - b. 555C - Ceiling Dampers.
    - c. 555S - Leakage Rated Dampers for Use in Smoke Control Systems.
  5. ASHRAE: 90.1 – 2019 Energy Efficient Design of New Buildings Except Low Rise Residential Buildings, with state amendments.

#### 1.4 SUBMITTALS

- A. Manufacturer's Literature:
1. Submit For:
    - a. Fire dampers.
    - b. Smoke dampers.
    - c. Fire/smoke dampers.
    - d. Airflow regulating dampers.

- e. Duct access doors and panels.
  - f. Gravity backdraft dampers.
  - g. Control dampers.
  - 2. Required Information:
    - a. General:
      - 1) Dimensions.
      - 2) Details of construction and installation.
      - 3) Name of Manufacturer.
      - 4) Model.
    - b. Control Damper:
      - 1) Air pressure drop.
      - 2) Leakage rate.
      - 3) Performance data as tested in accordance with AMCA Standards.
  - B. Operation and Maintenance Manuals: For each type of VAV damper.
    - 1. Equipment function, normal operating characteristics and limiting conditions.
    - 2. Assembly, installation, alignment, adjustment and checking instructions.
    - 3. Operating instructions for start-up, routine and normal operating, regulation and control, and shutdown and emergency conditions.
    - 4. Lubrication and maintenance instructions.
    - 5. Guide to "troubleshooting."
- 1.5 QUALITY ASSURANCE
- A. Fabrication and Installation Personnel Qualifications:
    - 1. Trained and experienced in the fabrication and installation of the materials and equipment.
    - 2. Knowledgeable of the design and the reviewed Shop Drawings.
  - B. Regulatory Agencies Requirements:
    - 1. UL:
      - a. Fire dampers shall conform to UL 555 and bear the UL label.
      - b. Radiation dampers shall conform to UL 555C and bear the UL label.
      - c. Smoke dampers shall conform to UL 555S and bear the UL label.
    - 2. Installation and materials shall be in accordance with:
      - a. All state and local codes and ordinances.
      - b. Owner's insurer.
- 1.6 SEQUENCING AND SCHEDULING
- A. Installation of control components at the Manufacturer's factory or in the field is optional only to the extent that schedule is not adversely affected.

## PART 2 - PRODUCTS

### 2.1 AIRFLOW REGULATING DAMPERS

- A. Manufacturers:
  - 1. Dampers:
    - a. American Warming and Ventilating, Inc.
    - b. Ruskin.
    - c. Louvers and Dampers, Inc.
    - d. Greenheck.
    - e. Pottorff.
    - f. Nailor.
  - 2. Regulators:
    - a. Duro-Dyne.
    - b. Ventlok.

- B. Provide accessible, manually operable dampers:
  - 1. At branch duct take-offs.
  - 2. At diffuser run-out take-offs.
  - 3. Downstream of duct coils.
  
- C. Dampers for Round Duct:
  - 1. For 8-inch and smaller, premanufactured dampers equal to Pottorff CD-10R. Provide quadrant standard bracket for insulated ductwork, coordinate with required insulation thickness on specified duct system.
  - 2. Field Fabricate Dampers:
    - a. Blade:
      - 1) Galvanized steel.
      - 2) Two gages heavier than duct in which installed.
    - b. Pivot rod continuous, 3/8-inch minimum for 12 inches and larger, 1/4-inch for under 12-inch size.
    - c. Hardware:
      - 1) For dampers less than 12 inches round, provide a dial regulator set consisting of 1 dial regulator, 1 square end bearing and 1 spring end bearing; equal to Durodyne Set No. KS-145 or KS145L.
      - 2) For dampers larger than 10 inches round, provide a dial regulator set consisting of 1 dial regulator, 1 square end bearing and 1 spring end bearing equal to Durodyne Set No. KSR-195 or KSR-195L.
  
- D. Dampers for Rectangular Duct:
  - 1. Field Fabricate Single Blade Dampers:
    - a. Blade:
      - 1) Galvanized steel.
      - 2) Two gages heavier than duct in which installed.
      - 3) 12-inch maximum height.
    - b. Pivot Rod:
      - 1) 3/8-inch pins up to 18-inch wide.
      - 2) 1/2-inch continuous rod over 18-inch wide.
  - 2. Dampers with Vertical Dimension Over 12 Inches:
    - a. Use opposed blade type.
    - b. Blade:
      - 1) 18-gage minimum galvanized steel.
      - 2) 12-inch maximum blade height.
      - 3) Hardware.
  
- E. Regulator:
  - 1. Quadrant type with handle and wingnut.
  - 2. Provide with integral insulation flange or standoff for installations on insulated ductwork.
  - 3. Provide end bearing.
  - 4. Equal to Duro Dyneset KS-12.
  
- F. Remote Controlled Dampers and Operators:
  - 1. Manually operated and mechanically linked damper regulator; equal to Ventlok #677 with plain cover, Ventlok #695 and #696 universal joints and Ventlok #601 joints and square rod.
  - 2. Manual Balancing Damper:
    - a. Equal to Ruskin model ZPD15 or Pottorff model RD-10.
    - b. Damper constructed with galvanized steel frame, 20 gage galvanized steel blade, 3/8-inch square axle shaft, synthetic or Lexan bearings, maximum static pressure of 2 inches, maximum velocity of 2,000 fpm.
    - c. With 9-volt powered gear drive actuator with optional remote damper control (1 required), wall box with cover plate and interconnecting cable.
  
- G. Dampers Upstream of Coils: Opposed blade type.



## 2.2 FIRE DAMPERS

- A. Manufacturers:
  - 1. Prefco.
  - 2. Ruskin.
  - 3. Pottorff.
  - 4. Greenheck.
  - 5. Louvers and Damper, Inc.
  - 6. Nailor.
  
- B. General Requirements:
  - 1. Fusible link actuated.
  - 2. Type B, 100% minimum free duct area with blade out of airstream.
  - 3. Installation of Type "A" fire dampers in an oversized duct is not an acceptable substitute for Type "B".
  - 4. UL Classified Fire Resistance Rating: 1-1/2 hours.
  - 5. Size dampers at grilles same size as grille unless otherwise noted.
  
- C. Provide where indicated on the Drawings and at code required locations in rated walls, floors and roofs.
  
- D. Test fire dampers in accordance with:
  - 1. UL Standard 555 or;
  - 2. A nationally recognized, qualified testing laboratory approved by the local authority:
    - a. Bearing the approved label of that laboratory.
    - b. Installed in accordance with test installation.

## 2.3 COMBINATION FIRE/SMOKE DAMPER

- A. Manufacturers:
  - 1. Prefco.
  - 2. Ruskin.
  - 3. Pottorff.
  - 4. Greenheck.
  - 5. Louvers and Damper, Inc.
  - 6. Nailor.
  
- B. General Requirements:
  - 1. UL classified fire resistance rating: 1-1/2 hours.
  - 2. UL leakage classification: I.
  
- C. Temperature responsive device actuated, constructed and installed in accordance with indicated details and SMACNA.
  
- D. Include electric motor operator for actuation by building smoke detectors. Electro-thermal link is not acceptable.
  
- E. Tested By:
  - 1. UL 555S or;
  - 2. Nationally recognized, qualified testing laboratory approved by the local authority:
    - a. Bearing the approved label of that laboratory.
    - b. Installed in accordance with test installation.
  
- F. Damper Blades: Airfoil type.
  
- G. Tested and rated for Dynamic Systems unless noted otherwise.
  
- H. Dampers shall not restrict free area of duct. Dampers at grilles shall be same size as the grille unless otherwise noted.
  
- I. Provide external means to indicate damper at open or closed position.

- J. Unless otherwise indicated, provide combination fire/smoke dampers at locations designated with an "F/S" adjacent to the fire damper symbol.

#### 2.4 SMOKE DAMPER

- A. Manufacturers:
1. Prefco.
  2. Ruskin.
  3. Pottorff.
  4. Greenheck.
  5. Louvers and Dampers, Inc.
  6. Nailor.
- B. Construction:
1. Construct damper frames of minimum gage galvanized sheet metal required by UL 555S Certification, with flanges for duct mounting with corner brackets to provide rigid frame.
  2. Damper blades shall not exceed 6 inches in width.
  3. Blades shall be airfoil shaped of extruded aluminum or galvanized steel double wall with 1/2-inch minimum 16 gage plated tube or solid axle keyed into pivot arms required by UL Certification .
  4. Bearings shall be stainless steel ball bearings, bolted to frame with seals.
  5. Blade Sealing:
    - a. Provide mechanically fastened or replaceable rubber or neoprene seals.
    - b. Install seals along the top, bottom and sides of the frame and along each blade edge.
    - c. Seal shall provide a tight closing low leakage damper.
    - d. Leakage shall not exceed AMCA Class 1.
    - e. Provide flexible stainless steel jamb seal.
  6. Damper blade interlock linkages shall drive the shaft of each blade, not the blade edge.
  7. Ruskin Model SD50, Pottorff Model SD-151, or equal.

#### 2.5 GRAVITY BACKDRAFT DAMPER

- A. Manufacturer:
1. American Warming & Ventilation, Inc.
  2. Pottorff
  3. Louvers & Dampers, Inc.
  4. Ruskin.
  5. Greenheck.
- B. General Requirements:
1. 0.070-inch extruded aluminum blades.
  2. 0.125-inch extruded aluminum frame.
  3. Adjustable counterbalanced blades.
  4. Mill finish.
  5. Low leakage.
  6. Operable down to 0.02-inch WG.
  7. Based on Ruskin Model CBD-6 or Pottorff CBD-250.

#### 2.6 AUTOMATIC CONTROL DAMPERS

- A. Manufacturer:
1. Ruskin.
  2. Greenheck.
  3. Pottorff.
  4. Louvers & Dampers, Inc.
  5. Johnson.
  6. Honeywell.

- B. General:
1. Provide single, multiple, parallel, or opposed blade as required.
  2. Parallel blade design for mixing applications, opposed blade for throttling application.
  3. Orient mixing dampers to converge the 2 airstreams.
  4. Provide opposed blade dampers for 2-position applications, except where noted otherwise.
  5. Where not indicated on the Drawings, damper construction shall be as follows:
    - a. Use standard dampers (as described below) for all applications, except as follows.
    - b. Use low leakage dampers whenever damper is used to isolate outside or contaminated air from a ducted airstream or air handling unit or wherever velocity exceeds 1500 fpm.
    - c. Use low leakage insulating dampers wherever damper is used to isolate outside or contaminated air directly from an occupied space or plenum (unducted).
    - d. When an economizer is required, use low leakage dampers wherever damper is used to isolate outside, exhaust, relief, return or contaminated air from a ducted airstream or air handling unit.
- C. Standard Construction:
1. Construct damper frames of minimum 16 gage galvanized sheet metal, with flanges for duct mounting with corner brackets to provide rigid frame.
  2. Damper blades shall not exceed 6 inches in width.
  3. Blades shall be galvanized steel with 1/2-inch minimum 16 gage plated tube or solid axle keyed into 12-gage pivot arms.
  4. The bearings shall be stainless steel sleeve type.
  5. Blade Sealing:
    - a. Provide silicone, TPV, neoprene or PVC coated fabric seals.
    - b. Seal shall provide a tight closing low leakage damper.
    - c. Leakage shall not exceed 11 CFM/SF at 4-inch W.G. for a 24-inch x 24-inch damper.
    - d. Provide flexible stainless steel jamb seal.
  6. Damper blade interlock linkages shall drive the shaft of each blade, not the blade edge.
  7. Ruskin Model CD36, Pottorff CD-41/42; or equal.
- D. Low Leakage Construction:
1. Construct damper frames of minimum 14 gage galvanized sheet metal, with flanges for duct mounting with corner brackets to provide rigid frame.
  2. Damper blades shall not exceed 6 inches in width.
  3. Blades shall be airfoil shaped of extruded aluminum double wall with 1/2-inch minimum 16 gage plated tube or solid axle keyed into 12-gage pivot arms.
  4. The bearings shall be synthetic sleeve type.
  5. Blade Sealing:
    - a. Provide mechanically fastened or replaceable TPV, PVC, rubber or neoprene seals.
    - b. Install seals along the top, bottom and sides of the frame and along each blade edge.
    - c. Seal shall provide a tight closing low leakage damper.
    - d. Leakage shall not exceed 8 CFM/SF at 4-inch W.G. for a 24-inch x 24-inch damper.
    - e. Provide flexible stainless steel jamb seal.
  6. Damper blade interlock linkages shall drive the shaft of each blade, not the blade edge.
  7. Ruskin Model CD50 or Pottorff CD-51/52; or equal.
- E. Low Leakage Construction - Insulating:
1. Construct damper frames of minimum 0.125-inch extruded aluminum, with flanges for duct mounting with corner brackets to provide rigid frame.
  2. Damper blades shall not exceed 6 inches in width.
  3. Blades shall be airfoil shaped of extruded aluminum double wall insulated with 1/2-inch minimum 16 gage plated tube or solid axle keyed into 12-gage pivot arms.
  4. The bearings shall be stainless steel sleeve type.
  5. Blade Sealing:
    - a. Provide mechanically fastened or replaceable TPV, PVC, rubber or neoprene seals.
    - b. Install seals along the top, bottom and sides of the frame and along each blade edge.
    - c. Seal shall provide a tight closing low leakage damper.
    - d. Leakage shall not exceed 8 CFM/SF at 4-inch W.G. for a 24-inch x 24-inch damper.
    - e. Provide Silicone or Neoprene jamb seal.
    - f. Submittal performance data must be for complete assembly.
  6. Damper blade interlock linkages shall drive the shaft of each blade, not the blade edge.
  7. Ruskin Model TED50, Pottorff Model TICD-51/52; or equal.

- F. Damper Operators: Furnish in accordance with the requirements of Division 23 Section "Instrumentation and Control for HVAC."

## 2.7 INSTRUMENT TEST HOLES

- A. Manufacturer: Ventlock Model 699; or equal.
- B. Provide at control points including but not necessarily limited to:
  - 1. Air temperature controller sensors.
  - 2. Pressure sensors.
  - 3. Temperature limit devices.
  - 4. Locations determined by Test and Balance Engineers.
- C. Compatible with duct external insulation thickness.

## 2.8 FABRICATION

- A. Corrosive Environments:
  - 1. Provide epoxy or other approved coating suitable for corrosion on control and balancing dampers installed in airstreams or environments subject to corrosive atmospheres.
  - 2. Fire and fire/smoke dampers installed in corrosive airstreams: Stainless steel.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. General:
  - 1. Install duct accessories in conformance with:
    - a. The Shop Drawings reviewed by Engineer.
    - b. SMACNA HVAC Duct Construction Standards and Fire, Smoke and Radiation Damper Installation Guide.
    - c. These specifications where different from SMACNA.
    - d. Manufacturer's written instructions.
  - 2. Locate branch dampers used for air flow regulation as close as possible to main trunks.
  - 3. Dampers shall not rattle or generate airborne noise of any kind regardless of damper position.
  - 4. Dampers located upstream of coils shall not interfere with uniform velocity profile at coil face.
  - 5. Locate and orient duct accessories according to Manufacturer's instructions relative to nearby fittings, elbows, and fans.
  - 6. Verify that dampers move freely through their entire stroke without binding.
- B. Access:
  - 1. Concealed duct accessories requiring inspection, service or maintenance shall be accessible.
  - 2. Provide acceptable means of access.
  - 3. Ensure that damper operator handles are not covered by insulation.

### 3.2 IDENTIFICATION

- A. Provide red stencil label on access doors to fire and fire/smoke dampers that reads "fire damper" or "fire/smoke damper."
- B. Where fire dampers are located above accessible ceilings, provide a cadmium plated screw with its head painted red in the ceiling below the damper.

END OF SECTION 23 33 13

## SECTION 23 34 23 – HVAC POWER VENTILATORS

### 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 furnishing and installation of power ventilators.
- B. Fans furnished as part of the air handling units are specified elsewhere.

#### 1.3 REFERENCES

- A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with the following:
  - 1. AMCA (Air Movement and Control Association) Standards:
    - a. 99 - Fabrication Standards.
    - b. 210 - Laboratory Method for Testing Fans for Aerodynamic Performance Rating.
    - c. 261 - Directory of Products Licensed to Use the AMCA Certified Ratings Seal.
    - d. 300 - Reverberant Room Method for Sound Testing of Fans.
  - 2. UL: 705 - Power Ventilators.
  - 3. ASHRAE: 90.1 – 2019 Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings, with state amendments.

#### 1.4 SYSTEM DESCRIPTION

- A. All power ventilators shall be selected as indicated on the Drawings:
  - 1. Airflow and static pressure indicated are minimums.
  - 2. Fan speed, brake horsepower (BHP) and sound ratings are maximum.
- B. Manufacturer name and model number information given in equipment schedules represent quality and performance standards for that equipment.
- C. Unless stated otherwise, fans shall be provided with the following:
  - 1. Discharge backdraft damper.
  - 2. Compatible curb or mounting hardware.
  - 3. Factory installed disconnect switch.
  - 4. Bird screen.
  - 5. OSHA approved beltguard.

#### 1.5 SUBMITTALS

- A. Shop Drawings: For exhaust fans.
  - 1. Dimensions.
  - 2. Details of construction and installation.
  - 3. Name of Manufacturer.
  - 4. Model.
  - 5. Fan identity by equipment schedule Tag No.
  - 6. Fan curve with selection point clearly indicated for CFM, total static pressure, BHP and RPM.
  - 7. Electrical characteristics and project specific wiring diagrams including control wiring.
  - 8. Fan sound power level in zones at rated capacity.

- B. Operation and Maintenance Manuals: For exhaust fans.
  - 1. Equipment function, normal operating characteristics and limiting conditions.
  - 2. Assembly, installation, alignment, adjustment and checking instructions.
  - 3. Operating instructions for start-up, routine and normal operating, regulation and control, and shutdown and emergency conditions.
  - 4. Lubrication and maintenance instructions.
  - 5. Guide to "troubleshooting."
  - 6. Parts lists and predicted life of parts subject to wear.

## 1.6 QUALITY ASSURANCE

- A. Fabrication and Installation Personnel Qualifications:
  - 1. Trained and experienced in the fabrication and installation of the materials and equipment.
  - 2. Knowledgeable of the design and the reviewed Shop Drawings.
- B. Regulatory Agencies Requirements:
  - 1. All state and local codes and ordinances.
  - 2. Owner's insurer.
- C. Quality Assurance:
  - 1. AMCA ratings program certified and bearing AMCA air and sound seals.
  - 2. UL listed electrical components.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. All power ventilators, except as indicated herein:
  - 1. Greenheck.
  - 2. Cook.
  - 3. Penn Barry.
  - 4. Aerovent.
  - 5. Acme.
- B. Electronically Commutated Motor: Motor shall be an electronic commutation (EC) motor specifically designed for fan applications. AC induction type motors are not acceptable. Examples of unacceptable motors are: Shaded Pole, Permanent Split Capacitor (PSC), Split Phase, Capacitor Start and 3 phase induction type motors. Motors shall be permanently lubricated with heavy-duty ball bearings to match the fan load and prewired to the specific voltage and phase. Internal motor circuitry shall convert AC power supplied to the fan to DC power to operate the motor. Motor shall be speed controllable down to 20% of full speed (80% turndown). Speed shall be controlled by either a potentiometer dial mounted on the motor or by a 0-10 VDC signal. Motor shall be a minimum of 85% efficient at all speeds.
  - 1. Provide with factory mounted and wired speed control:
  - 2. Motor and drive shall be accessible without disturbing ductwork.
  - 3. Motor shall be out of air stream.
  - 4. Motor Cover:
    - a. Constructed of galvanized steel
    - b. Covers motor and drives for safety
    - c. Standard on unit specified with UL

### 2.2 GENERAL REQUIREMENTS

- A. The equipment shall be factory built and factory tested.
- B. The Manufacturer shall repair or replace any items which fail to obtain specified performance.
- C. All fans shall be statically and dynamically balanced and tested.

## 2.3 DOMED CENTRIFUGAL ROOF VENTILATOR

- A. Housing:
  - 1. Low silhouette, weatherproof, heavy gage spun aluminum housing, self-supporting, enclosing venturi-orifice and fan inlet and wheel and overlapping fan curb.
  - 2. With rain and snow weather guard.
  - 3. Baked enamel finish, color as selected by Engineer.
  - 4. Aluminum bird screen in discharge outlet.
- B. Fan Wheel:
  - 1. All aluminum key locked to drive shaft, backward inclined, quiet nonoverlapping centrifugal fan wheel statically and dynamically balanced.
  - 2. Permanently lubricated fan bearing.
- C. Motor and Drive:
  - 1. Comply with the requirements of Division 23 Section "Common Motor Requirements for HVAC Equipment."
  - 2. Standard NEMA motors built-in overload constant speed.
  - 3. Resilient mounted outside of air stream, inside weatherproof housing.
  - 4. Disconnect switch mounted inside housing, with factory wiring to motor.
  - 5. Adjustable V-belt drive with 1.3 service factor.
- D. Roof Curb: Comply with the requirements of Division 23 Section "Penetrations for HVAC."
- E. Dampers: Refer to Division 23 Section "Dampers."

## PART 3 - EXECUTION

### 3.1 REQUIREMENTS

- A. Verify that openings and adjacent areas are free of obstructions, and ready to receive fans.
- B. Begin installation of fans only when openings conform to Specification requirements.
- C. Install fan(s) and accessories in accordance with Manufacturer's instructions.
- D. Secure components to openings and to each other.
- E. Adjust fan, belts and components as necessary for:
  - 1. Smooth operation.
  - 2. Proper running amperage.
  - 3. Minimum vibration.
- F. Replace components found out of alignment and balance.

END OF SECTION 23 34 23

## SECTION 23 36 00 – AIR TERMINAL UNITS

### 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 furnishing and installation of all variable air volume (VAV) terminal units.
- B. Cash Allowances: Work listed below to be completed by the temperature control system (T.C.S.) Subcontractor will be paid for from a cash allowance as specified in Division 01 Section "Cash Allowances" and performed by a T.C.S. contractor selected by Engineer.
- C. Division of Work:
  - 1. In accordance with the General Conditions, Contractor is responsible for dividing the Work among the Subcontractors and Suppliers and for delineating the work to be performed by specific trades.
  - 2. The following are suggestions as to how the Work may be divided. This is not a complete list of all the work:
    - a. General Contractor:
      - 1) Install access hatches for terminal units as directed by Mechanical Subcontractor.
    - b. Mechanical Subcontractor:
      - 1) Furnish all access doors as required for access to concealed terminal units.
      - 2) Coordinate with General Contractor for access hatch locations and installation.
      - 3) Furnish and install VAV terminal units in ductwork system and provide hangers and support.
    - c. Temperature Control Subcontractor:
      - 1) Provide control components:
        - a) Furnish to VAV terminal unit Manufacturer.
        - b) Complete field installation and calibrate.

#### 1.3 SYSTEM DESCRIPTION

- A. General:
  - 1. The assemblies shall be pressure independent and be able to reset to any airflow between 0 and a maximum cataloged cfm.
  - 2. Devices using cfm limits are not acceptable.
  - 3. Units shall be capable of morning warm-up operating control sequence.
- B. Design and Performance Requirements:
  - 1. Air leakage less than 2% at 0.5 inches w.c. static pressure.
  - 2. Control (pneumatic) air usage less than 0.02 SCFM at 20 psig.
  - 3. Space NC less than 35 at 2000 fpm inlet velocity.

#### 1.4 SUBMITTALS

- A. Shop Drawings: For all terminal units.
  - 1. General:
    - a. Dimensions.
    - b. Details of construction and installation.
    - c. Name of Manufacturer.
    - d. Model.
  - 2. For Each Unit:
    - a. Identify by schedule Tag No.
    - b. Air pressure drop at maximum position for specified airflow.
    - c. Acoustic data at specified maximum and minimum airflows.
    - d. Coil performance data.



- e. Fan performance data.
  - f. Electrical characteristics and project specific wiring diagrams including controls wiring.
- B. Operation and Maintenance Manuals: For each type of VAV terminal unit.
- 1. Equipment function, normal operating characteristics and limiting conditions.
  - 2. Assembly, installation, alignment, adjustment and checking instructions.
  - 3. Operating instructions for startup, routine and normal operating, regulation and control, and shutdown and emergency conditions.
  - 4. Lubrication and maintenance instructions.
  - 5. Guide to "troubleshooting".
  - 6. Parts lists and predicted life of parts subject to wear.

#### 1.5 QUALITY ASSURANCE

- A. Fabrication and Installation Personnel Qualifications:
- 1. Trained and experienced in the fabrication and installation of the materials and equipment.
  - 2. Knowledgeable of the design and the reviewed Shop Drawings.
- B. Regulatory Agencies Requirements:
- 1. The entire unit including heating coils shall be UL listed and labeled.
  - 2. All insulation in accordance with:
    - a. UL 181 for erosion.
    - b. NFPA 90A for fire and smoke.
  - 3. Installation shall comply with:
    - a. All state and local codes and ordinances.
    - b. Owner's insurer.

#### 1.6 SEQUENCING AND SCHEDULING

- A. Coordinate with sheet metal Subcontractor for scheduling of terminal unit installation so as to not delay the job.
- B. Installation of control components at the Manufacturer's factory or in the field is optional only to the extent that schedule is not adversely affected.

#### 1.7 WARRANTY

- A. Warranty shall cover all component parts for a period:
- 1. Not less than 36 months.
  - 2. Beginning from date of shipment.
- B. Manufacturer shall bear all costs:
- 1. For establishing and defining cause of unit's failure to perform as specified.
  - 2. For correcting or replacing all nonperforming units.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Environmental Technologies.
- B. The Trane Company.
- C. Titus.
- D. Carrier Corporation.
- E. Price.

## 2.2 MANUFACTURED UNITS

- A. Casing:
  - 1. Minimum 22 gage galvanized steel.
  - 2. Internally Lined:
    - a. Comply with the requirements of Division 23 Section "Duct Insulation" for internal lining material.
    - b. 1-inch glass fiber-free liner.
    - c. 3 pound density.
    - d. Cut edges shall be sealed with metal barriers.
  - 3. Full bottom access door.
- B. Damper:
  - 1. Galvanized steel or aluminum center pivot single blade or concentric sliding valve.
  - 2. Gasketed for positive closure.
  - 3. Rustproof self-lubricating bearings.

## 2.3 COMPONENTS

- A. Terminal Control Components - Electronic:
  - 1. Airflow Sensor and Transducer:
    - a. Multi-point airflow pick-up to provide a factory piped differential pressure signal to an airflow transducer assembly.
    - b. The pick-up shall maintain air accuracy of ( $\pm$ ) 5% of the normal operating range of the terminal as a minimum.
    - c. Integral flow taps and a calibration chart shall be provided with each unit.
  - 2. Terminal Damper Actuator - Electronic:
    - a. Direct coupled actuator used to control the primary air damper of the terminal control unit.
    - b. Constant current and torque limiting.
    - c. The actuator shall be factory mounted, wired and installed by the terminal unit Manufacturer.
    - d. Fully compatible with the electronic control signal for the T.C.S.
    - e. The actuator shall be capable of providing a minimum of 35-inch pounds of torque.
    - f. Capable of going from full open to full closed (or vice versa) in a maximum of 60 seconds.
  - 3. Terminal Box Controller Module:
    - a. Refer to Division 23 Section "Instrumentation and Control for HVAC" for controller module requirements.
    - b. Each BACnet device shall be BTL listed.

## 2.4 ACCESSORIES

- A. Electric Coil Section: Provide with SCR controlled electric coil with single side access to controls.
- B. Sound Attenuator: Provide with integral sound attenuator.

## 2.5 TERMINAL CONTROL UNIT POWER REQUIREMENTS

- A. All air terminal units shall be designed for single point power connections.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. As indicated on the Drawings.
- B. In accordance with Manufacturer's installation instructions.

END OF SECTION 23 36 00

## SECTION 23 37 00 – AIR OUTLETS AND INLETS

### 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 furnishing and installation of all air inlet and outlet devices.
- B. Division of Work:
  - 1. In accordance with the General Conditions, Contractor is responsible for dividing the Work among the Subcontractors and Suppliers and for delineating the work to be performed by specific trades.
  - 2. The following are suggestions as to how the Work may be divided. This is not a complete list of all the work:
    - a. General Contractor: Install stationary and adjustable louvers specified herein.
    - b. Mechanical Subcontractor:
      - 1) Furnish stationary and adjustable louvers specified herein.
      - 2) Coordinate with General Contractor for proper louver installation.

#### 1.3 REFERENCES

- A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with the following:
  - 1. AMCA Publications:
    - a. Standard 500 - Laboratory Methods of Testing Louvers for Rating.
    - b. Standard 511 - Certified Ratings Program for Air Control Devices.

#### 1.4 SUBMITTALS

- A. Manufacturer's Literature: For all items specified herein.
  - 1. General:
    - a. Dimensions.
    - b. Details of construction and installation.
    - c. Name of Manufacturer.
    - d. Model.
  - 2. Performance at Scheduled Airflow:
    - a. Maximum supply outlet throw value based on 50 fpm terminal velocity.
    - b. Maximum air pressure drop in inches water gage.
    - c. Maximum noise criteria (NC) level.
  - 3. Louvers:
    - a. Performance Ratings:
      - 1) AMCA Certified.
      - 2) For Engineer's approval prior to fabrication.

#### 1.5 QUALITY ASSURANCE

- A. Fabrication and Installation Personnel Qualifications:
  - 1. Trained and experienced in the fabrication and installation of the materials and equipment.
  - 2. Knowledgeable of the design and the reviewed Shop Drawings.

## PART 2 - PRODUCTS

### 2.1 REGISTERS, GRILLES, DIFFUSERS

- A. Manufacturers:
  - 1. Titus.
  - 2. Nailor.
  - 3. Anemostat.
  - 4. Price.
  
- B. General Construction Features:
  - 1. Refer to the Drawings for styles, types and design and materials.
  - 2. Return registers and grilles shall have fixed fins.
  - 3. Provide opposed blade, key operated dampers with registers.
  - 4. Provide sponge rubber gaskets at mounting flanges.
  - 5. Fit units with concealed mounting screws.
  - 6. Frame:
    - a. Provide factory manufactured frame to allow proper mounting to surface in which installed, i.e., plaster, concrete, T-bar, splined ceiling, etc.
    - b. Coordinate each case with architectural Drawings.
  
- C. Finish:
  - 1. Manufacturer's standard paint; color selected by Architect from manufacturer's standard color chart.
  - 2. Anodized acceptable where standard for specific item.
  - 3. White color for suspended ceiling installations, except where noted as black.
  
- D. Accessories:
  - 1. Provide where indicated or required.
    - a. Equalizing grid.
    - b. Neck mounted damper.
    - c. Remote damper.
  
- E. Manufacturer/model numbers are scheduled on Drawings to indicate performance criteria, appearance style and quality of materials.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Follow Manufacturer's instructions, subject to Engineer's approval.
  
- B. Install registers, grilles and diffusers only after finish painting has been completed.
  
- C. Install fixed vane return and exhaust grilles with angle of vanes perpendicular to normal line-of-sight.

### 3.2 ADJUSTING

- A. Set pattern controllers on slot diffusers and set vanes on adjustable diffusers to provide air flow patterns as indicated on the Drawings.

### 3.3 PAINTING

- A. Unlined Ductwork:
  - 1. Where visible behind registers, grilles and diffusers.
  - 2. Apply flat black paint:
    - a. 2 coats.
    - b. In accordance with Division 09 – Finishes.

END OF SECTION 23 37 00

## SECTION 23 40 00 – HVAC AIR CLEANING 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.

#### 1.2 SUMMARY

- A. This Section includes, but is not limited to, the furnishing and installation of air cleaning devices:
  - 1. Disposable air filters.
  - 2. Filter housings.

#### 1.3 REFERENCES

- A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with the following:
  - 1. Air Conditioning, Heating, and Refrigeration Institute (AHRI): Standard 850, 2004 – Performance Rating of Commercial and Industrial Air Filter Equipment.
  - 2. American Society of Heating Refrigeration and Air Conditioning Engineers (ASHRAE): Standard 52.2 - Methods for Testing General Ventilation Air Cleaning Devices for Removal Efficiency by Particle Size.
  - 3. Underwriters Laboratories (UL):
    - a. UL586 – High Efficiency, Particulate, Air Filter Units.
    - b. UL867 – Electrostatic Air Cleaners.
    - c. UL900 – Standard for Air Filter Units.
  - 4. Military Specifications and Standards (MIL): MIL-STD-282 – Filter Units, Protective Clothing, Gas-Mask Components, and Related Products Performance Test Methods.

#### 1.4 SUBMITTALS

- A. Filter Schedule:
  - 1. List each filter application individually, including:
    - a. Type(s) of filter(s) applied.
    - b. Manufacturer and model number for each type used.
    - c. List filters by size and quantity.
- B. Manufacturer's Literature: For each separate installation.
  - 1. Dimensions.
  - 2. Name of Manufacturer.
  - 3. Model.
  - 4. Certified performance data.
    - a. Efficiency.
    - b. Air pressure drop at stated airflow.
  - 5. Filter frame materials of construction.
  - 6. Motor specification, electrical characteristics, connections.

- C. Cleaning and maintenance instructions.

#### 1.5 QUALITY ASSURANCE

- A. Regulatory Requirements:
  - 1. State and local codes and ordinances.
  - 2. Owner's insurer.
  - 3. UL listed and labeled Class 2.

1.6 DELIVERY, STORAGE AND HANDLING

- A. All materials shall be delivered in original, unbroken, brand marked containers or wrapping as applicable.
- B. Handle and store materials in a manner which will prevent deterioration or damage, contamination with foreign matter and damage by weather or elements in accordance with Manufacturer's directions.
- C. Reject damaged, deteriorated or contaminated material and immediately remove from the Site. Replace rejected materials with new materials at no additional cost to Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. American Air Filter.
- B. Camfil Farr Company.
- C. AAF Flanders.
- D. Cambridge.
- E. Fiberbond.
- F. Trion, Inc. (Electrostatic only).

2.2 DISPOSABLE MEDIA FILTERS

- A. Extended Surface, Pleated Filters:
  - 1. UL 900, Class 1, Non-woven pleated cotton and synthetic fabric bonded to a wire support grid.
  - 2. Beverage board enclosing frame with diagonal support members.
  - 3. Effective filter media shall not be less than 4.6 square feet of media per 1 square foot of filter face area.
  - 4. Nominal Size: 24 x 12 x 1-inch thickness.
  - 5. ASHRAE 52.2 Performance:
    - a. MERV 8.
    - b. 85% arrestance by weight.
    - c. Initial resistance at 500 fpm face velocity: 0.20 inch WG.
    - d. Final resistance at 500 fpm face velocity: 0.90 inch WG.
- B. Cartridge Filters:
  - 1. Media: UL 900 Class 1 pleated, non-woven cotton fabric, scrim reinforced; supported by welded steel retainer; in 16 gage, 0.0598 inch steel holding frame with corrosion resistant coating.
  - 2. Welded wire media support grid.
  - 3. Galvanized steel contour stabilizers.
  - 4. Galvanized steel enclosing frame with diagonal supports on entering and leaving sides of filter.
  - 5. Effective Media Area: 16 sq ft per 1000 CFM capacity rating.
  - 6. Nominal Size: 24 x 24 x 12 inches deep.
  - 7. ASHRAE 52.2 Performance:
    - a. Minimum Efficiency Reporting Value (MERV): 13.
    - b. 92% average arrestance by weight.
    - c. Initial Resistance at 500 FPM Face Velocity: 0.20 inch WG.
    - d. Recommended Final Resistance: 0.50 inch WG above initial resistance.

2.3 FILTER HOUSINGS:

- A. Minimum 16-gage galvanized steel.
- B. Two access doors with neoprene gaskets, full height hinges and tight sealing clamp type closures.

- C. Extruded aluminum tracks or 14-gage minimum mounting grid designed to accommodate intended filters without leakage.

#### 2.4 ACCESSORIES

- A. Holding Frames:
  - 1. Compatible with filters.
  - 2. 16-gage minimum galvanized steel for pleated filters.
  - 3. 14-gage minimum galvanized steel for cartridge filters.
  - 4. Flush mitered corners.
  - 5. Fully gasketed with retaining clips for a positive seal between the frame and the filter media.
- B. Differential Pressure Gage:
  - 1. Manufacturer: Dwyer Magnahelic Model 2002.
  - 2. Range: 0 to 2.0-inch water column.
  - 3. Size: 4-inch diameter dial readout.
  - 4. Static Pressure Tips: 4-inch long Model 302.
  - 5. Connections: Use rubber hose to connect tips to gage.

#### 2.5 SOURCE QUALITY CONTROL

- A. Filter Housing:
  - 1. Leakage upstream to downstream of through housing shall be less than 1% at 3-inch WG differential.
  - 2. Leakage into housing from ambient shall be 0.5% or less at 3-inch WG negative.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Install in such a manner as to prevent air leakage around filter/frame assembly.
- B. Provide additional support for banks of frames over 3 frames high.
- C. Calk around the perimeter of assembled frames.
- D. Mount static pressure tips with angled end portion upstream.

#### 3.2 SCHEDULE

- A. Filter Applications:

Equipment	Air Cleaning Device	Units	Thickness	Efficiency
Rooftop Units Pre Filter	Pleated Filter	RTU	2"	MERV 8
Rooftop Units – Final Filter	Cartridge Filter	RTU	12"	MERV 13

END OF SECTION 23 40 00

## SECTION 23 74 43 – PACKAGED, OUTDOOR HEATING AND COOLING UNITS

### 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 furnished and installation of packaged rooftop air handling unit(s).

#### 1.3 SYSTEM DESCRIPTION

- A. General:
  - 1. Factory assembled packaged unit suitable for roof-mounting and outdoor installation.
  - 2. All components functionally joined on a common base.
  - 3. Complete in every way, ready for electrical, ductwork, piping and control connections.
- B. Major components include, but are not necessarily limited to, the following:
  - 1. Gas heating section.
  - 2. Filter module.
  - 3. Supply fan.
  - 4. Economizer section.
  - 5. Compressor/condenser system with DX coil.
  - 6. Prefabricated curb.
  - 7. Factory-mounted controls.
  - 8. Hot gas bypass.
  - 9. Hot gas reheat.
  - 10. Return fan.
  - 11. Humidifier.
  - 12. 120 Volt GFCI receptacle.
  - 13. Frequency drive for fan motor.
- C. Design and performance requirements as indicated on the Drawings.

#### 1.4 REFERENCES

- A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with the ASHRAE Standard: 90.1 - 2019 Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings, with state amendments.

#### 1.5 SUBMITTALS

- A. Shop Drawings: For complete unit.
  - 1. Manufacturer's name and model number.
  - 2. Dimensioned Drawings:
    - a. Curb.
    - b. Unit plan and elevation.
  - 3. Size and Performance Data:
    - a. Fans.
    - b. Refrigeration equipment.
    - c. Heating section.
    - d. Coils.
  - 4. Details of construction and installation.
  - 5. Project specific electrical wiring diagrams including controls wiring.
  - 6. Control schematic.



- B. Operation and Maintenance Manuals: For completed unit and individual components.
  - 1. Equipment function, normal operating characteristics and limiting conditions.
  - 2. Assembly, installation, alignment, adjustment and checking instructions.
  - 3. Operating instructions for start-up, routine and normal operating, regulation and control, and shutdown and emergency conditions.
  - 4. Lubrication and maintenance instructions.
  - 5. Guide to "troubleshooting".
  - 6. Parts lists and predicted life of parts subject to wear.
  - 7. Outline, cross-sections, assembly drawings, engineering data and wiring diagrams.
  - 8. Test data and performance curves.

#### 1.6 QUALITY ASSURANCE

- A. Fabrication and Installation Personnel Qualifications:
  - 1. Trained and experienced in the fabrication and installation of the materials and equipment.
  - 2. Knowledgeable of the design and the reviewed Shop Drawings.
- B. Manufacturer's Services:
  - 1. Provide start-up by factory-employed personnel of installed unit.
  - 2. Provide training for Owner's personnel.
- C. Regulatory Organizations Requirements:
  - 1. All electrical wiring must comply with NEC.
  - 2. Comply with all applicable state and local codes and ordinances.

#### 1.7 SEQUENCING AND SCHEDULING

- A. Expedite approval of Shop Drawings so as not to delay unit installation.

#### 1.8 WARRANTY

- A. Provide extended warranty of 5 years total on all compressors from equipment startup.
- B. Provide 25-year warranty on stainless steel heat exchangers.

#### 1.9 PERFORMANCE REQUIREMENTS

- A. Wind-Restraint Performance:
  - 1. Basic Wind Speed: 120 mph
  - 2. Building Classification Category: II.
  - 3. Minimum 16 lb/sq. ft multiplied by the maximum area of the mechanical component projected on a vertical plane that is normal to the wind direction, and 45 degrees either side of normal.
  - 4. Design shall not consider shielding by adjacent structures.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Trane.
- B. Aaon.
- C. Design is based on equipment as scheduled. Changes in equipment Manufacturer must meet minimum requirements listed in this Specification or on Drawings and be compatible with facility and intended use. Contractor shall be responsible for any additional costs caused by selection of equipment from the list of acceptable alternative Manufacturers, including any redesign efforts by the Engineer.

- D. Note that a listing above as an acceptable Manufacturer does not imply that all Manufacturers listed can furnish equipment which complies with the requirements for each unit used on this project.

## 2.2 CABINET, CASING AND FRAME

- A. Frame and Base Unit:
1. 14 gage galvanized steel.
  2. Provide lifting brackets with lifting holes.
- B. All cabinet walls, access doors and roof shall be fabricated of rigid, impact resistant, double wall, high performance composite panels with G90 galvanized steel on both sides (18 gage minimum) and a closed cell polyurethane foam interior core.
- C. Foam shall have a minimum density of 2 pounds/cubic foot and shall be tested in accordance with ASTM D-1929 for a minimum flash ignition temperature of 610 degrees F.
- D. Panel deflection shall not exceed L/240 ratio at 125% of design static pressure, minimum 8 inches of positive or negative static pressure. Deflection shall be measured at the midpoint of the panel height and width.
- E. Access: Access to filters, dampers, cooling coils, reheat coil, heaters, supply fans, exhaust fans, return fans, energy recovery wheels, compressors, water-cooled condensers, and electrical and controls components shall be through hinged access doors with quarter turn, zinc cast, lockable handles. Full length stainless steel piano hinges shall be included on the doors.
- F. Cabinet leakage rate shall not exceed 1% when tested at 6 inches of static pressure.
- G. Exterior paint finish shall be capable of withstanding at least 2,500 hours, with no visible corrosive effects, when tested in a salt spray and fog atmosphere in accordance with ASTM B 117-95 test procedure.
- H. Sealants shall comply with EPA Method 24 40 CFR 59, Subpart D for VOC content.
1. Metal to Metal: 30 g/L.
  2. Fiberglass: 80 g/L.
- I. Insulation:
1. All cabinet surfaces and access panels.
  2. Minimum 13.0 R value.
  3. Double wall with thermal break construction with no metal path from inside to outside.
  4. Foam in place insulation.

## 2.3 SUPPLY FAN AND RETURN FAN

- A. Fan:
1. Centrifugal type.
  2. Statically and dynamically balanced.
  3. Wheel and housing to be with aluminum wheel.
  4. Shaft:
    - a. Solid steel.
    - b. Mounted in 200,000-hour rated, relubricatable ball bearing assemblies.
- B. Motor: Comply with the requirements of Division 23 Section "Common Motor Requirements for HVAC Equipment." Provide with variable speed drive factory-wired and mounted.
- C. Vibration Isolation:
1. Completely isolate entire fan assembly from the unit bulkhead with spring isolators.
  2. Provide spring isolation of compressors.
  3. Entire unit shall be mounted on a double deflection spring isolation system between the unit and the curb.
  4. Comply with the requirements of Division 23 Section "Sound and Vibration Control for HVAC."

## 2.4 FURNACE

- A. Burner:
1. Forced draft, natural gas fired modulating type capable of efficient operation from 33% through 100% of rated capacity.
  2. Factory fire tested and adjusted prior to shipment.
- B. Heat Exchanger:
1. Tubular type.
  2. Fabricated of type 304 stainless steel.
  3. Secondary heat exchanger design shall permit free expansion and contraction of individual sections and tubes.
  4. Provide for heat exchanger cleaning without removing casing panels.
  5. Provide flame observation port opposite the burner.
  6. With 25 year warranty.
- C. Provide complete gas train including main gas valve, main pressure regulator, main shutoff cock, pilot gas valve, pilot pressure regulator, pilot cock and electronic flame supervision.
1. Comply with FM and IRI requirements.
- D. Control:
1. Burner on/off modulating and staging control shall be by a unit-mounted micro-processor controller .
  2. On-board control package shall include flame supervision, integral prepurge timing combustion air proving switch and intermittent pilot with spark ignition.

## 2.5 REFRIGERATION SYSTEM

- A. Compressor:
1. Compressors shall be heavy-duty, hermetic scroll type with oil pump, suction and discharge line service valves, crankcase heater and inherent solid-state thermal overload protection.
  2. Each compressor shall have its own completely independent refrigeration circuit including sight-glass, filter-drier, manual shutoff valve and spring-tube high pressure relief valve.
  3. Compressors shall be isolated on spring isolators.
  4. Compressor capacity reduction shall be accomplished with hot-gas bypass variable capacity compressors with 10:1 turn-down.
- B. Condensing Coil:
1. The condensing unit section shall be open on the sides to ensure complete access to and airflow through coils.
  2. Condenser coils shall be multi-row type fabricated from 3/8-inch O.D. seamless copper tubing mechanically bonded to rippled and corrugated aluminum fins.
  3. Condenser coil for each refrigerant circuit shall be provided with an additional circuit for a minimum of 15 degrees of subcooling.
  4. Each condenser coil shall be factory leak tested at 200 psig under water.
- C. Condenser Fans:
1. Condenser fans shall be direct drive, propeller type designed for low tip speed and vertical air discharge.
  2. Fan blades shall be constructed of steel and riveted to an Iridite dipped steel center hub.
  3. Condenser fan motors shall be heavy-duty, inherently protected, 3-phase nonreversing type with permanently lubricated ball bearings and integral rain shield.
- D. Evaporator Coil:
1. Evaporator coils shall be multi-row type fabricated from 3/8-inch [ 5/8-inch ] O.D. seamless copper tubing mechanically bonded to rippled and corrugated aluminum fins, with a maximum of [ 12 ] fins per inch.
  2. Coils shall be factory leak tested at 200 psig under water.
  3. The evaporator coil circuitings shall be fed with an adjustable thermal expansion valve (1 per refrigerant circuit) with an external equalizer.
  4. The evaporator coil shall be circuited for a row split.

- E. Control:
1. Each compressor circuit shall include a liquid line solenoid valve, oil pressure switch, high pressure switch, low pressure switch, pump-down switch, and compressor control circuit switch.
  2. Each refrigeration circuit shall have at least 1 condenser fan controlled from an ambient thermostat for positive head pressure control.
  3. An ambient thermostat shall prevent the refrigeration system from operating below 50 degrees F.
  4. An adjustable 5-minute timer shall be provided for each compressor circuit to prevent short cycling.
- F. Condensate Drain:
1. A stainless steel primary drain pan shall be provided with the cooling coil and extend beyond the leaving side of the coil and underneath the cooling coil connections.
  2. The drain pan shall be connected to a threaded drain connection extended through the unit base.
  3. Manufacturer shall demonstrate that the unit is designed and constructed such that all overflow from the drain pan cannot enter the building when correctly installed on the curb and the overflow will instead spill onto the roof. Alternatively, a pre-wired water monitoring device in compliance with Paragraph 307.2.3.1 of the latest edition of the International Mechanical Code may be used.
- G. Hot Gas Reheat Coil:
1. Factory piped to lead compressor circuit.
  2. Downstream of evaporator coil.
  3. Controlled in accordance with the requirements of Division 23 Section "Instrumentation and Control for HVAC."

## 2.6 FILTER SECTION

- A. Housing:
1. Provide galvanized steel filter housing as integral section of unit with access doors.
  2. Provide separate tracks for pre-filters and final filters.
- B. Filters:
1. As manufactured by Farr Company; or equal.
  2. Prefilter:
    - a. 2-inch depth, MERV 8.
    - b. 25% minimum efficiency per ASHRAE Test Standard 52.
  3. Final Filter:
    - a. Cartridge type with rigid frame.
    - b. 85% efficiency per ASHRAE Test Standard 52.
  4. Provide clogged filter switch with 24-volt dry contact.

## 2.7 ECONOMIZER SECTION

- A. Configuration: Outside and return air section shall form a plenum with outdoor air introduced through horizontal intake hood complete with rain lip and bird screen.
- B. Drainage: Floor of outdoor air section shall be sloped for water drainage.
- C. Relief Damper:
1. Provide a gravity relief damper in the return air section to exhaust air out of unit.
  2. Damper contact edges to be lined with urethane gasketing.
- D. Outdoor and Return Air Dampers:
1. Dampers shall be constructed of 14 gage aluminum and mounted on circular shafts for easy rotation.
  2. Damper blades shall be operated from multiple sets of linkages mounted on the leaving face of the dampers.
  3. The outside and return air dampers shall be sized to handle 100% of the supply air volume and arranged to converge the 2 air streams in a circular mixing pattern.
- E. Provide storm-proof louver or hood and bird screen to prevent infiltration.

- F. Refer to Division 23 Section "Instrumentation and Control for HVAC" for economizer operating sequence.

## 2.8 ELECTRICAL

- A. Wiring:
  - 1. Each unit shall be wired and tested at the factory before shipment.
  - 2. Wiring shall comply with NEC requirements and shall conform with all applicable UL standards.
  - 3. All wiring shall be number coded in accordance with the electrical wiring diagrams.
- B. Components:
  - 1. All electrical components shall be labeled according to the electrical diagram and be UL recognized where applicable.
  - 2. Each unit shall have the following:
    - a. A 115 volt control circuit transformer.
    - b. System service switch and control circuit fuse.
    - c. 115 volt GFCI receptacle that will remain energized when unit disconnect is open.
- C. Overload Protection:
  - 1. All motor branch circuits shall be individually fused.
  - 2. Contactors and inherent thermal overload protection shall be furnished for each compressor and condenser fan motor.
  - 3. The supply air fan motors shall have contactors and external overload protection.
- D. Control Panel:
  - 1. Main control panel shall be of weatherproof construction with a dead-front cover over the main power circuit controls.
  - 2. Furnish with integral latch/disconnect switch to cut power to unit before opening control panel door.
  - 3. A separate control panel shall house all controls for the refrigeration section.
  - 4. Each BACnet device shall be BTL listed.
- E. Connections:
  - 1. A terminal block shall be provided for the power connection and a terminal board shall be provided for the low voltage control wiring.
  - 2. Knockouts shall be provided in the bottom of the main control panel for field wiring entrance.

## 2.9 ROOF CURB

- A. Furnish in accordance with the requirements of Division 23 Section "Penetrations for HVAC."
- B. Curb shall be a perimeter type with complete perimeter support for the air handling and refrigeration section.
- C. Furnish gasketing material for field mounting between unit base and curb.
- D. Wind Restraints: Metal brackets compatible with the curb and casing, painted to match RTU, used to anchor unit to the curb, and designed for loads at Project site.
- E. Wind Restraint Straps and Base Flange Attachment: Provide wind restraint straps, welded strap connectors, and base flange attachment to roof structure at perimeter of curb, of size and spacing required to meet wind uplift requirements.

## 2.10 CONTROLS

- A. Provide unit-mounted microprocessor-based control package to provide sequence of operation as described in Division 23 Section "Instrumentation and Control for HVAC."
  - 1. Unit mounted control shall be capable of stand alone.
  - 2. Provide communication interface with building management system.

- B. Field-Mounted Components:
  - 1. Provide remote sensor to be mounted in supply and return duct at remote location.
  - 2. Duct Smoke Detectors:
    - a. Provide photoelectric type detectors:
      - 1) UL listed, Standard 268A.
      - 2) 24 volt.
      - 3) Visible LED alarm.
      - 4) Auxiliary contacts.
      - 5) Multi-length air sampling type.
      - 6) Uniform sensitivity over full range of air velocities characteristic of specific installation.
    - b. Capable of detecting combustion gases, fire and smoke in air conditioning and ventilation systems in compliance with the NFPA Standards 72E and 90A.
    - c. Provide detectors compatible with the building fire alarm system to allow interfacing. Detectors are to be powered from the fire alarm system.
    - d. Manufacturer: Simplex 2098 series, or as approved.
  - 3. Duct Smoke Detectors:
    - a. Provide dry contacts to allow shut-down of unit by either supply or return air smoke detectors (furnished under Division 26).
    - b. Refer to Division 23 Section "Instrumentation and Control for HVAC."

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Verify that roof is ready to receive work, all auxiliary support steel is in place, and opening dimensions are as recommended by unit Manufacturer.
- B. Verify that proper power supply is available.

#### 3.2 COMMISSIONING

- A. In addition to the requirements above, the Manufacturer's representative shall be on Site for a minimum of 1 day to demonstrate compliance with operational intent and Start-up Checklists.

#### 3.3 INSTALLATION

- A. Install in accordance with Manufacturer's instructions.
- B. Contractor shall verify that decay resistant shimmed wood blocking is level and square prior to installing roof curb.
- C. Prior to lifting units onto curbs, Contractor shall install gasketing material (furnished by rooftop unit Manufacturer) along full curb perimeter and all around supply and return duct openings.
- D. Units shall be lowered carefully onto curbs with equal overhang on 4 sides.
- E. Curbs shall be installed so that top of curb is level. Installation shall be waterproof. Contractor shall verify that there are no excessive weld fillets in the corners of curb. All roof penetrations and flashings shall be completed in such a manner to ensure maintenance of roofing warranty. Curb perimeter shall be insulated.
- F. Contractor shall do all necessary interconnecting of wiring and assembly of sections if the units are shipped in sections.
- G. Provide installation accessories as detailed, including installing P-traps on all units.
- H. Contractor to install plastic piping for condensate drain.
- I. Contractor shall install outside air hoods (furnished with unit) according to Manufacturer's instructions.

- J. Air Cleaning: Refer to Division 23 Section "General HVAC Provisions" for construction period filter change requirements.
- K. Unit Controls: Refer to Division 23 Section "Instrumentation and Control for HVAC."
- L. Wind and Seismic Restraints: Metal brackets compatible with the curb and casing, painted to match RTU, used to anchor unit to the curb, and designed for loads at Project site.
- M. Wind Restraint Straps and Base Flange Attachment: Provide wind restraint straps, welded strap connectors, and base flange attachment to roof structure at perimeter of curb, of size and spacing required to meet wind uplift requirements.

END OF SECTION 23 74 43

## SECTION 23 82 50 – ELECTRIC CONVECTION HEATING UNITS

### 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 furnishing and installation of electric resistance heating units.

#### 1.3 DESIGN AND PERFORMANCE REQUIREMENTS:

- A. Basis of Design: As indicated on the Drawings.

#### 1.4 REFERENCES

- A. As herein specified, the work of this Section shall comply with the following:
  - 1. ASHRAE Standard: 90.1 – 2019 Energy Efficient Design of New Buildings Except Low Rise Residential Buildings, with state amendments.

#### 1.5 SUBMITTALS

- A. Manufacturer's Literature: For all unit heaters.
  - 1. Dimensions.
  - 2. Details of construction and installation.
  - 3. Name of Manufacturer.
  - 4. Model.
  - 5. Wiring diagrams for power and controls.
- B. Operation and Maintenance Manuals: For all unit heaters.
  - 1. Equipment function, normal operating characteristics and limiting conditions.
  - 2. Assembly, installation, alignment, adjustment and checking instructions.
  - 3. Operating instructions for start-up, routine and normal operating, regulation and control, and shutdown and emergency conditions.
  - 4. Lubrication and maintenance instructions.
  - 5. Guide to "troubleshooting".
  - 6. Parts lists and predicted life of parts subject to wear.
  - 7. Outline, cross-sections, assembly drawings, engineering data and wiring diagrams.
  - 8. Test data and performance curves.

#### 1.6 QUALITY ASSURANCE

- A. Fabrication and Installation Personnel Qualifications:
  - 1. Trained and experienced in the fabrication and installation of the materials and equipment.
  - 2. Knowledgeable of the design and the reviewed Shop Drawings.
- B. Regulatory Agencies Requirements:
  - 1. Assembly to comply with requirements of:
    - a. National Electric Code.
    - b. OSHA.
  - 2. Assembly to be UL labeled.

#### 1.7 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials shall be delivered in original, unbroken, brand marked containers.



- B. Handle and store materials in a manner which will prevent deterioration or damage, contamination with foreign matter, damage by weather or elements, and in accordance with Manufacturer's directions.
- C. Reject damaged, deteriorated or contaminated material and immediately remove from the Site. Replace rejected materials with new materials at no additional cost to Owner.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Q'Mark.
- B. Indeeco.
- C. Trane.
- D. Markel.
- E. Modine.

### 2.2 CABINET UNIT HEATERS

- A. Cabinet:
  - 1. 16 gage steel with exposed corners and edges rounded.
  - 2. Front Panel:
    - a. Easily removable.
    - b. Glass fiber insulated.
    - c. Inlet and outlet duct connectors.
  - 3. Finish:
    - a. Exposed surfaces in baked enamel.
    - b. Color by Architect.
- B. Electrical Configuration:
  - 1. Aluminum-finned, copper-clad steel sheath heating elements, warranted for 5 years.
  - 2. Built-in overload protection with automatic reset.
  - 3. Power disconnect switch.
  - 4. Power Requirements:
    - a. 480 volt, 3 phase, 60 Hz.
    - b. Single point connection.
    - c. Provide integral transformers required for component voltage reduction.
- C. Fans:
  - 1. Centrifugal with forward-curved DWDI wheels.
  - 2. Statically and dynamically balanced.
  - 3. Direct driven on sleeve bearings.
  - 4. Resiliently mounted.
- D. Filter:
  - 1. 1-inch thick glass fiber.
  - 2. Easily removed throw-away type.
  - 3. Located on inlet side of coil.
- E. Control:
  - 1. 4-position motor speed switch.
  - 2. Factory wired.
  - 3. Remote wall mounted thermostat with remote sensor mounted in return air duct.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install heating units in conformance with:
  - 1. The Shop Drawings reviewed by Engineer.
  - 2. The Manufacturer's recommendations.
- B. Mount heater to wall structure.
- C. Make power and control wiring connections.
- D. Verify proper operation before turning over to Owner.

END OF SECTION 23 82 50

## SECTION 26 05 00 – COMMON WORK RESULTS FOR ELECTRICAL

### 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. Excess Quantities and Sizes: Where quantities, sizes or other requirements on Drawings or Specifications are in excess of code requirements, Drawings or Specifications govern.
- C. Conflicts: When conflicts exist between referenced Specifications or standards, more stringent requirements govern. No extra compensation for such compliance allowed.

#### 1.2 SUMMARY

- A. This Section includes the following:
  - 1. Electrical equipment coordination and installation.
  - 2. Sleeves for raceways and cables.
  - 3. Sleeve seals.
  - 4. Grout.
  - 5. Duct seal.
  - 6. Duct seals and plugs.
  - 7. Common electrical installation requirements.

#### 1.3 REFERENCES

- A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with
  - 1. NECA 1 - Standards Practices for Good Workmanship in Electrical Construction.
  - 2. NEC – National Electrical Code (NFPA 70).

#### 1.4 DEFINITIONS

- A. EPDM: Ethylene-propylene-diene terpolymer rubber.

#### 1.5 SUBMITTALS

- A. Product Data: For sleeve seals.

#### 1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials in original, unbroken, brand marked containers or wrapping as applicable.
- B. Handle and store materials in a manner which will prevent deterioration, damage, contamination with foreign matter, and damage by weather or elements, and according to Manufacturer's directions.
- C. Store materials indoors and protect from weather. When necessary to store outdoors, elevate materials above grade and enclose with durable, weather tight wrapping.
- D. Reject damaged, deteriorated, or contaminated material and immediately remove from the Site. Replace rejected materials with new materials at no additional cost to Owner.

## 1.7 COORDINATION

- A. Coordinate arrangement, mounting, and support of electrical equipment:
  - 1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
  - 2. To ensure that mounting heights and locations of electrical equipment do not interfere with all other building appurtenances such as, but not limited to, containment areas, special coatings, and other equipment.
  - 3. To allow easy access and disconnection of electrical equipment while ensuring the least amount of interference with other installations.
  - 4. To allow right-of-way for piping and conduit installed at required slopes.
  - 5. To ensure that connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and outside of the dedicated working and access space of other equipment.
- B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- C. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed.
- D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Firestopping."

## PART 2 - PRODUCTS

### 2.1 SLEEVES FOR RACEWAYS AND CABLES

- A. Steel Pipe Sleeves: ASTM A53/A53M, 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 on the Drawings.
- C. Sleeves for Rectangular Openings: Galvanized sheet steel.
  - 1. Minimum Metal Thickness:
    - a. For sleeve cross-section rectangle perimeter less than 50 inches and no side more than 16 inches, thickness shall be 0.052 inch.
    - b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches and 1 or more sides equal to, or more than, 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 raceway or cable.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Advance Products & Systems, Inc.
    - b. Calpico, Inc.
    - c. Metraflex Co.
    - d. Pipeline Seal and Insulator, Inc.
    - e. Proco Products, Inc.
  - 2. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
  - 3. Pressure Plates: Carbon steel.
  - 4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

### 2.3 GROUT

- A. Nonshrink; recommended for interior and exterior for sealing openings in non-fired-rated walls or floors.

- B. Standard: ASTM C1107, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5,000 psi, 28 day compressive strength.
- D. Packaging: Premix and factory packaged.

#### 2.4 DUCT SEAL

- A. Description: UL listed, pliable, non-hardening, non-corrosive, weather-proof putty material, designed as a moisture barrier for weather-sealing service entries, electrical cables, and conduit ducts.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Arnco Corp. - Hydra-Seal.
    - b. Ilsco Corp. – DS Duct Seal.
    - c. JM Clipper – Duxseal.
    - d. OZ/Gedney Co. – DUX.
    - e. RectorSeal - Duct Seal Compound.
    - f. Thomas & Betts Corp. - DX.
    - g. Or equal.

#### 2.5 DUCT SEALS AND PLUGS

- A. Cable duct seals and plugs shall be designed to effectively seal conduits, reducing the cost of cable placement and maintenance in underground construction projects and routine work.
  - 1. All plastic construction – corrosion proof.
  - 2. Pull 'Rope Eye' attachment (can be supplied with security hex nut).
  - 3. Water tight.
  - 4. Simple to install.
  - 5. Removable and reusable.
  - 6. Full range of sizes.
  - 7. Full range of forms (round, square).
  - 8. Full range of supported cable count (simplex, duplex, triplex, quadplex and specials).
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. TE Connectivity.
  - 2. Or equal.

### PART 3 - EXECUTION

#### 3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

- A. Comply with NECA 1 and NEC.
- B. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
- C. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in a manner as to facilitate future disconnecting with minimum interference with other items in the vicinity.
- D. Right of Way: Give to piping systems installed at a required slope.

#### 3.2 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.
- 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. 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.
- E. Cut sleeves to length for mounting flush with both surfaces of walls.
- F. Extend sleeves installed in floors 2 inches above finished floor level.
- G. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable, unless otherwise indicated on the Drawings.
- H. Seal space outside of sleeves with grout for penetrations of concrete and masonry. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.
- I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants."
- J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Firestopping."
- K. Roof-Penetration Sleeves: Roof penetrations shall be made using EMT, IMC, and RMC. Seal all penetrations of individual raceways with flexible boot-type flashing units applied in coordination with roofing work.
- L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using 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.
- M. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

### 3.3 SLEEVE-SEAL SYSTEM INSTALLATION

- A. Install sleeve-seal systems onto sleeves of exterior concrete walls and slab-on-grade at raceway entries into buildings.
- B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

### 3.4 FIRESTOPPING

- A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Firestopping."

### 3.5 DUCT SEAL INSTALLATION

- A. Install duct seal materials in strict accordance with the Manufacturer's instructions.
- B. Obtain approval from Engineer prior to installing duct seal as the application may require duct seals and plugs to be utilized in lieu of duct seal.

3.6 DUCT SEALS AND PLUGS INSTALLATION

- A. Where conduits penetrate into the building, seal duct openings at conduit termination points with duct seals and plugs for all conduits entering the building to prevent migration of water and gases into the building and to prevent the condensation of water vapor inside the enclosures where the conduits terminate.
- B. Duct seals and plugs shall be applied after all cables have been installed.
- C. Install duct seals and plug materials in strict accordance with the Manufacturer's instructions.
- D. Where conduit will be simultaneously exposed to different temperatures, such as where it passes through the outside wall of a heated building or between two different rooms, the inside of the conduit shall be sealed with duct seals and plugs.
- E. All raceways that penetrate in to or out of manholes, vaults, buildings, freezers, coolers, roofs, or like installations shall require duct seals and plugs to be installed,
- F. All open ended riser conduits shall require duct seals and plugs to be installed.

END OF SECTION 26 05 00

## SECTION 26 05 20 – CONDUCTORS AND CABLES – 600V AND BELOW

### 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 furnishing and installation of all electrical conductors, cables, splices, and connectors.
- B. Major Systems Include:
  - 1. 600V and below service entrance, feeders and electrical distribution.
  - 2. Branch circuit wiring.
  - 3. System wiring.

#### 1.3 REFERENCES

- A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with the standards of the following organizations as applicable to materials, construction and testing of wire cables:
  - 1. NEMA - National Electrical Manufacturer Association Standards.
  - 2. IEEE Standards.
  - 3. Insulated Cable Engineers Association - Standards.
  - 4. ASTM Standards.
  - 5. NEC - National Electrical Code (NFPA 70).

#### 1.4 SUBMITTALS

- A. Product Data: For each type of product.

#### 1.5 QUALITY ASSURANCE

- A. Fabrication and Installation Personnel Qualifications:
  - 1. Trained and experienced in the fabrication and installation of the materials and equipment.
  - 2. Knowledgeable of the design and the reviewed submittals.
- B. Manufacturers: Firms regularly engaged in the manufacture of electrical conductor and cable products of the types and ratings required, whose products have been in satisfactory use in similar service for not less than 5 years.

#### 1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver all materials in original, unbroken, brand marked containers or wrapping as applicable.
- B. Handle and store materials in a manner which will prevent deterioration or damage, contamination with foreign matter, damage by weather or elements, and in accordance with Manufacturer's directions.
- C. Store materials indoors and protect from weather. When necessary to store outdoors, elevate materials above grade and enclose with durable, watertight wrapping.
- D. Reject damaged, deteriorated, or contaminated materials and immediately remove from the Site. Replace rejected materials with new materials at no additional cost to Owner.



## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. General: Except as otherwise indicated, provide conductors, cables, and connectors of Manufacturer's standard materials, as indicated by published product information; designed and constructed as recommended by the Manufacturer and as required for the installation.
- B. Power Wire:
1. All conductors and cables shall be new with a minimum wire size of No. 12 AWG. Manufacturer's name, type, and size shall be permanently marked on the outer covering at regular intervals and delivered in complete coils or reels.
  2. Provide factory fabricated conductors of size, rating, material, and type as indicated for each service. Where not indicated, provide proper selection as determined by installer to comply with installation requirements and with NEC standards, from only the following types and conductors:
    - a. Type THHN/THWN-2 dual rated, 600-Volt, 90 degrees C rated.: Stranded copper for all sizes.
    - b. Bare Conductors: Stranded copper for all sizes.
- C. Metal Clad (Type MC) Cables:
1. Type THHN/THWN-2 insulated copper conductors, with insulated green grounding conductor routed with the circuit conductors.
  2. High strength, lightweight, galvanized steel flexible interlocking armor, UL listed and labeled for UL Standards 1569 and 83.
  3. Thermoplastic insulated bushing for each cable end.
  4. Manufacturers: MCTUFF Lightweight Steel MC Metal Clad Cables by AFC Cable Systems; or equal.
- D. Control Cable: No. 14 AWG minimum, type THHN/THWN-2.
- E. Instrumentation Signal Cable:
1. No. 16 AWG stranded, tinned copper conductors, 600V polyethylene insulation, twisted pair, 100% coverage aluminum polyester shield, No. 18 AWG stranded, tinned copper drain wire with vinyl outer jacket, UL listed.
  2. 600V rated for outdoor or below grade installations.
  3. 300V rated indoors, above grade or inside control panels.
  4. Manufacturers: Belden; Alpha; West Penn, General Cable.
- F. Power Wiring Cable Accessories: For Connectors:
1. Wing nuts by Ideal.
  2. Sta-Kon by Thomas & Betts.
  3. Scotchlox Spring by Minnesota Mining & Manufacturing Company.
  4. Compression Type 53200 by Thomas & Betts.
  5. Hydent by Burndy.
  6. Insulated multi-cable mechanical connector blocks by Polaris, or IlSCO.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. General:
1. Install electrical conductors, cables, and connectors as indicated on the Drawings, in accordance with the Manufacturer's written instructions, the applicable requirements of NEC and the National Electrical Contractors Association's "Standard of Installation," and in accordance with recognized industry practices to ensure that products serve the intended functions.
  2. Conductors and cables shall be sized in accordance with the Drawings or, in the absence thereof, in accordance with NEC requirements. Except where indicated herein, conductor sizes greater than No. 12 AWG are indicated on the Drawings.
  3. Provide a dedicated grounded conductor (neutral) for each circuit that requires a neutral for proper operation. Unless indicated otherwise on the Drawings, shared neutrals are not allowed.
  4. Provide an equipment grounding conductor in all raceways. Conductor shall be sized in accordance with the National Electrical Code.

- B. Voltage Drop Compensation:
1. Provide No. 10 AWG conductors in lieu of No. 12 AWG conductors to compensate for voltage drop as follows:
    - a. For each 277V, 20 ampere branch circuit that exceeds 200 feet in length between the branch circuit panelboard and the last outlet.
    - b. For each 120V, 20 ampere branch circuit that exceeds 100 feet in length between the branch circuit panelboard and the last outlet.
  2. When conductor size is increased to compensate for voltage drop, provide equipment grounding conductor increased in size in accordance with NEC.
- C. Installation Procedures:
1. Install interior conductors after building is enclosed and water tight.
  2. Each conduit shall be free of moisture and debris before conductors are installed.
  3. Remove moisture from conduits by swabbing.
  4. Install conductors so insulation is not damaged. Replace all conductors that are damaged.
  5. Install conductors and cables only in code conforming raceway.
  6. Pull conductors together where more than one conductor is being installed in a raceway.
  7. Use heat shrink tubing for all instrument signal cable terminations.
  8. Use manufacturer-approved pulling compound or lubricant, where necessary. Compound shall not deteriorate conductor and insulation. Compounds shall be UL listed.
  9. Use a pulling means, including fish tape, cable or rope, and basket-weave wire/cable grips that will not damage the raceway or the wire.
  10. Keep conductor splices to a minimum.
  11. Install splices and taps which have equivalent or better mechanical strength and insulation as the conductor.
  12. Use splice and tap connectors which are compatible with the conductor material.
  13. Make all joints, splices, and connections only at accessible junction or outlet boxes, never inside conduit or fitting. Make splices in No. 10 AWG and smaller wire with insulated spiral mechanical connectors.
  14. Make splices in No. 8 AWG and larger copper wire with compression type mechanical connectors.
  15. All splices located in handholes and wet locations shall be rated for wet locations.
  16. Low voltage and signal cable splices located in handholes and wet locations shall be sealed in 2-part epoxy sealing pack, 3M Scotchcast connector sealing pack 3570G.
  17. Make conductor length for parallel feeds identical.
  18. Where exposed cables are installed, cables shall be installed parallel and perpendicular to exposed structural members and building lines.
  19. Do not lace, strap or tie feeder or branch circuit conductors together in panels, switchboards, variable speed drives, motor control centers, automatic transfer switches, boxes, and wireways.
  20. All conductors and cables shall be identified in accordance with Division 26 Section "Identification for Electrical Systems."
  21. Use color coded conductors as follows:
    - a. Phases: Black-red-blue (under 150V to ground).
    - b. Phases: Brown-orange-yellow (over 150V to ground).
    - c. Neutral: White (under 150V to ground).
    - d. Neutral: Grey (over 150V to ground).
    - e. Ground: Green identified (feeders); Green (branch circuits).
  22. Support conductors in vertical raceways in accordance Division 26 Section "Hangers and Supports for Electrical Systems."
  23. Outlets:
    - a. Leave at least 6 inches of free conductor at all outlets except where conductors are intended to loop without joints through outlets for fixtures or wiring device hook-ups.
    - b. Free ends and loops at boxes and enclosures shall be pushed back into boxes and protected by blank cover plates or other means until interior painting and decorating work is completed.
  24. Lights and outlets shall be grouped on circuits as indicated on the Drawings. Different types of circuits such as feeders, branch circuits, control circuits, and signal circuits, shall not be mixed in common conduit runs, but shall be run separately, although more than 1 circuit of the same system may be run in common conduit runs.
  25. Conductor ampacity derating shall be adhered to for all conductors in accordance with the National Electrical Code.
  26. Type MC cable may only be used for branch circuit wiring, and switch legs when located above dropped ceilings, and in stud walls. Type MC cable shall originate from accessible junction boxes above ceilings. Do not use Type MC cable in hazardous or wet locations or for feeders. Do not install Type MC cable directly into panelboards.

### 3.2 FIELD QUALITY CONTROL

#### A. General:

1. Prior to energization, check conductors and cables for continuity of circuitry and for short circuits. Correct malfunctions when detected.
2. Subsequent to conductor and cable hook-ups, energize circuitry and demonstrate functioning in accordance with requirements.

END OF SECTION 26 05 20

## SECTION 26 05 27 – GROUNDING AND BONDING

### 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 furnishing and installation of a complete and continuous grounding system.

#### 1.3 SUBMITTALS

- A. Test Reports: For grounding. Grounding electrode resistance test results.

#### 1.4 DESIGN AND PERFORMANCE REQUIREMENTS

- A. All equipment, raceway systems, interior wiring systems with neutrals, receptacles, and power outlets, motors and motorized equipment shall be grounded.

#### 1.5 QUALITY ASSURANCE

- A. Fabrication and Installation Personnel Qualifications:
  - 1. Trained and experienced in the fabrication and installation of the materials and equipment.
  - 2. Knowledgeable of the design.
- B. Grounding system shall be in accordance with the current National Electrical Code (NEC).
- C. Grounding system rods, connectors and clamps shall be UL labeled.

### PART 2 - PRODUCTS

#### 2.1 MATERIALS

- A. General: A portion of the required materials for grounding systems are specified in the Division 26 – Electrical Sections.
- B. Grounding Electrodes:
  - 1. Ground Rods: Copper-clad steel; 3/4-inch diameter by 10 feet in length.
  - 2. Where ground grids are required they shall consist of copper clad steel driven rods with underground ring bus, sized as indicated on Drawings, of bare stranded copper interconnecting cable.
  - 3. Ground rods to be as manufactured by Copperweld; or equal.
- C. Connectors:
  - 1. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions as manufactured by Thomas and Betts; or equal.
  - 2. Irreversible Compression Connectors: Compression connections shall be irreversible, cast copper, high conductivity as manufactured by Thomas and Betts; or equal.
- D. Telecommunications Grounding Busbar:
  - 1. Telecommunications Grounding Busbar (TGB): Rectangular, electro-tin plated, annealed, copper bus bars; 1/4-inch x 2-inch x 18-inch; with insulators, stainless steel mounting brackets, and fasteners. Manufacturer: Erico "ERITECH" TGB Series grounding busbar.

### PART 3 - EXECUTION

#### 3.1 POWER SYSTEM GROUNDING

- A. Make cable to cable connections by using exothermic-welding process, or irreversible compression type connectors made for direct burial.
- B. Irreversible compression connectors shall be factory filled with an oxide inhibitor and installed with the connector manufacturer's die such that the die index matches the listed index on the connector. Connectors shall be fully crimped with a 14 ton or larger hydraulic tool such that the index number is embossed on the connector. Irreversible compression connectors may be used in below grade, above grade, building steel, electrode connections and concrete encased applications. Connectors shall comply with IEEE 837, UL467 and CSA22.2.
- C. Connect grounding electrode conductors to service entrances and separately derived systems in accordance with the NEC.

#### 3.2 DISTRIBUTION SYSTEM GROUNDING

- A. Provide a green, insulated, equipment grounding conductor in each raceway (metallic and non-metallic; rigid and flexible). Equipment grounding conductors shall be sized in accordance with Article 250 of the NEC.
- B. Circuit Grounding: Install grounding bushings, grounding studs, and grounding jumpers at distribution centers, pull boxes, motor control centers, panelboards, load centers, and all like equipment.
- C. Bonding Jumpers:
  - 1. Provide green insulation, size correlated with overcurrent device protecting the wire, attached to grounding bushings on conduits, to lugs on boxes, and other enclosures.
  - 2. Bond to neutral only at service neutral bar.
- D. Receptacles and Power Outlets: Ground receptacles and power outlets to the conduit system with a green grounding conductor sized in accordance with Article 250 of the NEC and connected between the device grounding screw and outlet box.
- E. Metallic Conduit: When bare grounding electrode conductors are enclosed in metallic conduit, the conduit shall be bonded to the grounding electrode conductor(s) at both ends utilizing equipment UL listed for this purpose.
- F. Ground motor bases and frames by pulling a separate equipment grounding conductor in with the motor branch circuit.
- G. Expansion Joints: Provide a bonding jumper around expansion fittings in metallic conduit to maintain ground continuity. Expansion fittings may include an internal bonding jumper constructed of a tinned copper braid, sized to meet UL fault current test requirements and complying with the bonding requirements of Article 250 of the NEC.
- H. Separately Derived Systems: Grounding of separately derived systems, i.e., secondary transformers, shall be in accordance with Article 250 of the NEC. Use suitable ground lugs and clamps approved for this purpose.

#### 3.3 TELECOMMUNICATIONS SYSTEMS GROUNDING

- A. Intermediate Telecommunications Rooms:
  - 1. Install a Telecommunications Grounding Busbar (TGB) in each intermediate telecommunications room.
  - 2. Provide a No. 4 AWG, insulated grounding conductor in non-metallic conduit, to bond each TGB to the TMGB in the main telecommunications room.

END OF SECTION 26 05 27

## SECTION 26 05 29 – 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.

#### 1.2 SUMMARY

- A. This Section includes the furnishing and installation of hangers and supports for electrical equipment and systems.

#### 1.3 DEFINITIONS

- A. Electrical Supports: Angles, channels, brackets, and mounting accessories for supporting all conduit, luminaires, switches, and other electrical equipment which are hung or mounted above floor.

#### 1.4 DESIGN AND PERFORMANCE REQUIREMENTS

- A. This Section defines general criteria for the selection and installation of supporting devices, but does not cover all types specifically required for the Project.
- B. Choose or design supporting devices in accordance with these general criteria.

#### 1.5 QUALITY ASSURANCE

- A. Fabrication and Installation Personnel Qualifications:
  - 1. Trained and experienced in the fabrication and installation of the materials and equipment.
  - 2. Knowledgeable of the design and the reviewed submittals.
- B. Regulatory Agencies Requirements:
  - 1. Provide supporting devices listed by Underwriters' Laboratory for their application as installed.
  - 2. Comply with National Electrical Code (NFPA 70) as applicable to construction, installation, and requirements for supporting devices.
  - 3. Comply with Metal Framing Manufacturers Association Standard Publication (MFMA-4); factory-fabricated components for field installation.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver all materials in original, unbroken, brand marked containers or wrapping as applicable.
- B. Handle and store materials in a manner which will prevent deterioration or damage, contamination with foreign matter, damage by weather or elements, and in accordance with Manufacturer's directions.
- C. Store materials indoors and protect from weather. When necessary to store outdoors, elevate materials above grade and enclose with durable, watertight wrapping.
- D. Reject damaged, deteriorated, or contaminated material and immediately remove from the Site. Replace rejected materials with new materials at no additional cost to Owner.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. Conduit Supports:
1. Where information indicated on Drawings conflicts with information herein, the more stringent requirements shall take precedence and the better quality or greater quantity of work shall be provided.
  2. Single Runs: Galvanized conduit straps or ring bolt type hangers with spring clips. Do not use plumber's perforated straps.
  3. All supports, such as, but not limited to, metal channel (strut) framing systems, angles, straps, hangers, etc. shall match the raceway type that is being supported. For example, galvanized conduit requires galvanized metal channel (strut) framing systems and straps, PVC coated conduit requires PVC coated metal channel (strut) framing systems and straps, PVC conduit requires PVC channel (strut) framing systems and straps.
  4. In general, all hardware, such as anchors, nuts, bolts, washers, threaded rod, etc. shall match the conduit type: Galvanized steel hardware shall be used with galvanized steel rigid metal conduit; 316 stainless steel hardware shall be used with PVC and PVC coated rigid metal conduit.
  5. Multiple Runs: Conduit rack with 25% spare capacity.
  6. Vertical Runs: Channel support with conduit fittings.
  7. Manufacturers:
    - a. Cooper B-Line; a division of Eaton Corporation.
    - b. ERICO International Corporation.
    - c. Power-Strut; Power Engineering Co., Inc.
    - d. GS Metals Corp.
    - e. Michigan Hanger Co., Inc.; O-Strut Div.
    - f. National Pipe Hanger Corp.
    - g. Thomas & Betts Corporation.
    - h. Unistrut; a brand of Atkore International, Inc.
    - i. Wesanco Channel Systems; ZSi-Foster, Inc.
    - j. Or equal.
- B. Mounting, Anchoring, and Attachment Components
1. 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 where used. See item 2.1 A 5 above for clarification.
  2. 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.
  3. Manufacturers:
    - a. Hilti, Inc.
    - b. ITW Construction Products.
    - c. MKT Fastening, LLC.
    - d. Or equal.
- C. Supports for Conductors in Vertical Conduit:
1. Install in compliance with NEC article 300.19.
  2. 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.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

##### A. General:

1. Layout to maintain headroom, neat mechanical appearance, and to support equipment loads.
2. Secure Engineer's approval before welding or bolting to steel framing or anchoring to concrete structure.
3. Where equipment is to be suspended from cast-in-place concrete construction, set approved concrete inserts in formwork to receive hanger rods. Where equipment is to be suspended from metal deck and beam or joist construction, support equipment from beams or joists only.

END OF SECTION 26 05 29



## SECTION 26 05 34 – 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.

#### 1.2 SUMMARY

- A. This Section includes the furnishing and installation of conduits and fittings for electrical wiring.

#### 1.3 SUBMITTALS

- A. PVC Coated RMC Installers: Submit Manufacturer's certified training record (i.e., sign-in sheet on Manufacturer's letterhead) for all employees trained and certified to install PVC Coated RMC.
- B. Product Data:
  - 1. For surface raceways, wireways and fittings.
    - a. Name of Manufacturer.
    - b. Model number.
    - c. Details of construction and installation.
    - d. Electrical specifications and ratings.
    - e. Dimensional data.
    - f. Color and finish.

#### 1.4 QUALITY ASSURANCE

- A. Fabrication and Installation Personnel Qualifications:
  - 1. Trained and experienced in the fabrication and installation of the materials and equipment.
  - 2. Knowledgeable of the design.
- B. Regulatory Agencies Requirements:
  - 1. ACI – American Concrete Institute: Standards pertaining to conduits embedded in concrete (Section 6.3 in ACI 318 – Building Code Requirements for Structural Concrete and Section 6.3 in ACI 350R – Environmental Engineering Concrete Structures.)
  - 2. NEMA – National Electrical Manufacturer's Association – Standards pertaining to raceways.
  - 3. NEC – National Electric Code – As applicable to construction and installation of conduit system.
  - 4. Provide conduit which is listed and labeled by Underwriters' Laboratories.

#### 1.5 DELIVERY, STORAGE AND HANDLING

- A. Deliver all materials in original, unbroken, brand marked containers or wrapping as applicable.
- B. Handle and store materials in a manner that will prevent deterioration or damage (e.g., bending, end damage, finish scoring), contamination with foreign matter, damage by weather or elements, and in accordance with Manufacturer's directions.
- C. Store materials indoors and protect from weather. When necessary to store outdoors, elevate materials above grade and enclose with durable, watertight wrapping. Provide color coded end cap thread protectors on exposed threads of threaded metal conduit.
- D. Reject damaged, deteriorated, or contaminated material and immediately remove from the Site. Replace rejected materials with new materials at no additional cost to Owner.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. Rigid Metal Conduit (RMC):
  - 1. Galvanized Steel RMC: Galvanized steel, heavy wall conduit with threaded fittings, 3/4-inch trade size minimum, insulated bushings.
- B. Electrical Metallic Tubing (EMT):
  - 1. Thin wall, hot galvanized, steel tubing, 1/2-inch trade size minimum with insulated throat steel connector.
  - 2. Fittings: Steel compression or setscrew type (die cast fittings are expressly prohibited).
- C. Surface Metal Raceway (SMR):
  - 1. One-piece steel raceway with a factory assembled base and cover with associated fittings. Finish shall be tough, durable, and scratch-resistant, suitable for field painting. Type and Manufacturer: 700WH, white surface metal raceway as manufactured by Wiremold; or equal.
  - 2. Two-piece steel raceway including a base with snap-on cover and associated fittings. Finish shall be tough, durable, and scratch-resistant, suitable for field painting. Type and Manufacturer: 2400-FW, fog white surface metal raceway as manufactured by Wiremold; or equal.
  - 3. Two-piece steel raceway including a base (divided into two compartments of 1/3 and 2/3 the width of the raceway) and snap-on cover and associated fittings. Finish shall be tough, durable, and scratch resistant, suitable for field painting. Type and Manufacturer: 2400D-FW, fog white, as manufactured by Wiremold; or equal.
  - 4. Two-piece, multiple channel steel raceway including a base and snap-on cover. Base shall be dividable into 2 compartments by means of a removable barrier section. Finish shall be ivory scratch resistant, suitable for field painting. Type and Manufacturer: G4000, grey as manufactured by Wiremold; or equal.
  - 5. UL listed.
  - 6. Fittings, couplings, junction boxes, and accessories as required. Color to match raceway.
- D. Rigid Nonmetallic Conduit (RNMC):
  - 1. Schedule 40, rigid polyvinylchloride, rated for 90 degrees C conductors, 3/4-inch trade size minimum, solvent cement connectors and couplings.
  - 2. Nonmetallic strap hangers allowing thermal expansion movement.
  - 3. Conduit to meet NEMA TC-2; fittings to meet NEMA TC-3.
  - 4. Expansion Coupling: Nonmetallic to compensate for thermal expansion.
- E. Flexible Metal Conduit (FMC): 3/4-inch trade size minimum with galvanized steel flexible conduit insulated throat steel connectors.
- F. Liquid Tight Flexible Metal Conduit (LTFMC): 3/4-inch trade size minimum. Flexible conduit with flexible, moisture-proof PVC jacket and liquid tight connectors.
  - 1. In Corrosive Locations, LTFMC fittings shall be nonmetallic.
- G. Conduit Hubs for RMC and IMC:
  - 1. Suitable for environment served.
  - 2. Grounding screw.
  - 3. O-ring gasket.
  - 4. Material: Malleable Iron with zinc electroplate.
  - 5. Manufacturer:
    - a. Cooper Myers Hubs.
    - b. Thomas & Betts.
    - c. Killark.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Unless otherwise specified or indicated on the Drawings, conceal conduit to the extent possible.
  - 1. In finished areas where conduit cannot physically be concealed due to existing conditions, provide surface metal raceway. Finished areas are generally, but not always: above grade, heated spaces with finished walls (e.g., painted, drywall, etc.), finished floors (e.g., painted concrete, carpet, tile, etc.), and finished ceilings (e.g., drywall, suspended ceiling grids, wood, etc.).
  - 2. Conduit shall not be concealed within tank walls, slabs, or ceilings.
  - 3. Do not conceal conduit in Corrosive Locations.
  
- B. Exposed conduit permitted in:
  - 1. Plant spaces.
  - 2. Service equipment rooms.
  - 3. Rooms without finished ceilings (overhead only).
  - 4. Unfinished rooms.
  
- C. Install conduit products in accordance with:
  - 1. The Drawings.
  - 2. The Manufacturer's written instructions.
  - 3. Applicable requirements of NEC and National Electrical Contractors Association's "Standard of Installation."
  - 4. Recognized industry practices to ensure that products serve intended function.
  
- D. Conduit Joints: Cut square, reamed smooth and drawn up tight.
  
- E. Threaded Conduit Joints: Apply listed anti-corrosion/anti-seize compound to threads of raceway and fittings before making up joint. Follow compound manufacturer's written instructions.
  
- F. Bends:
  - 1. Number per run for conduit that support feeder and branch circuits: Do not exceed the equivalent of 4 quarter bends (360 degrees) between pull points.
  - 2. Number per run for conduit that supports data/communications cabling: Do not exceed the equivalent of 2 quarter bends (180 degrees) between pull points.
  - 3. Make bends and offsets so as not to reduce the inner diameter of the conduit.
  - 4. To the extent possible, avoid using large junction boxes as 90 degree junctions.
  
- G. Routing:
  - 1. Concealed Conduits: Run in a direct line with long sweep bends and offsets.
  - 2. Exposed Conduits: Run parallel to, and at right angles to, building lines.
  - 3. Run continuous from outlet to outlet and from outlets to cabinets, pull or junction boxes.
  - 4. Secure to boxes and cabinets with locknuts and bushings in such a manner that each system is electrically continuous throughout.
  
- H. Cap conduit ends to prevent entrance of foreign materials during construction.
  
- I. Provide insulated bushings on threaded conduit run terminations. Where entering the bottom of open-bottom switchboards, motor control centers, transformers, primary switches, and similar equipment provide bonding bushings and bonding jumpers.
  
- J. Where entering the bottom of open-bottom equipment (i.e., switchboards, panelboards, motor control centers, transformers, and similar equipment) conduit shall not be installed flush with the floor/equipment pad and shall not rise more than 3 inches above the bottom of the enclosure.
  
- K. Conduit entering control panels shall not obstruct internal components and shall allow for neat and workmanlike wire management.
  
- L. Completely install conduit systems before installing conductors.

- M. Refer to Division 26 Section "Common Work Results for Electrical" for sealing underground and above grade conduit that is exposed to temperature differences to prevent the passage of air and condensation.
- N. Support:
1. Where information on Drawings conflicts with information herein, the more stringent requirements shall take precedence and the better quality or greater quantity of work shall be provided.
  2. Adequately support conduit from structural elements of the building.
  3. Do not drill or tap structural building steel without approval from Engineer.
  4. Do not rest raceways or wiring systems on, nor support it from, ceiling suspension systems, ceiling tiles or mechanical equipment including, but not necessarily limited to ductwork and fans.
  5. Conduit shall be supported in accordance with the NEC and Division 26 Section "Hangers and Supports for Electrical Systems."
- O. Provide conduit expansion couplings where conduits cross building or structure expansion joints.
- P. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200 pound (90 kg) tensile strength. Label and leave at least 12 inches of slack at each end of pull wire.
- Q. SMR Installation:
1. Raceway Systems: Mechanically continuous and connected to electrical outlets, boxes, cabinets, in accordance with manufacturer's installation sheets.
  2. Steel Raceway: Be electrically continuous and bonded in accordance with the National Electric Code for proper grounding.
  3. Raceway Supports: Securely supported at intervals not exceeding 4 feet or in accordance with manufacturer's installation sheets.
  4. Raceway Systems Installation: Installed complete, including insulating bushings and inserts where required by manufacturer's installation sheets. Unused raceway openings shall be closed.
- R. FMC and LTFMC Installation:
1. Provide separate grounding conductor in accordance with Division 26 Section "Grounding and Bonding."
  2. Connection to light fixtures shall not exceed 6 feet in length within an accessible ceiling and 3 feet in length where exposed. Connection to solenoids, pressure switches, motors, fans, HVAC equipment, and similar equipment shall not exceed 3 feet in length.
  3. Flexible conduit shall not be used to connect to surface mounted light fixtures or other non-moving, non-vibrating, or non-adjustable equipment.
- S. Rigid Nonmetallic Conduit Installation:
1. Provide separate grounding conductor in accordance with Division 26 Section "Grounding and Bonding."
  2. Support conduit in accordance with the NEC.
  3. Provide expansion couplings where length change due to temperature variation exceeds 1/4-inch.
  4. When penetrating concrete surfaces or grade, make a transition to rigid steel conduit 6 inches (minimum) below the surface. Provide corrosion protection by coating the RMC with a bituminous coating from inside the encasing material to 4 inches of exposed conduit; vinyl corrosion protection tape may be installed, but must be reviewed with the Engineer prior to installation.
  5. Provide rigid steel elbows in all conduit that is underground or encased in concrete.
- T. Firestopping: Firestop all conduit penetrations of fire rated barriers by using approved material to ensure integrity of the rating.
- U. Underground Installation:
1. As indicated on the Drawings, including the excavating, pumping, backfilling, shoring and removal of surplus excavated material.
  2. Underground Obstructions:
    - a. Locate all that may interfere with excavation.
    - b. Be responsible for damage to existing underground systems and assume all cost of repairing the same.
  3. Backfilling:
    - a. Use only clean sand thoroughly compacted to prevent settling of trenched areas.
    - b. In the event that backfilled areas do settle, fill and compact to finish grade, and repair all damage caused by settling.

4. Repair all disturbed surface to match existing.
5. Unless otherwise indicated on the Drawings, install top of conduit 30 inches below grade when located outside the walls of the building.
6. Provide warning ribbon 12 inches above conduits.

V. Embedment in Concrete:

1. Where conduit is embedded in concrete, follow the requirements of Section 6.3 in ACI 318 – Building Code Requirements for Structural Concrete and Section 6.3 in ACI 350R – Environmental Engineering Concrete Structures.
2. Review proposed routing of embedded conduit with Engineer prior to installation.
3. Embedded conduit shall be installed between top and bottom reinforcement, in a manner that prevents concrete from entering the conduit system.

3.2 CONDUIT SCHEDULE

- A. Where information on Drawings conflict with information herein, the more stringent requirements take precedence and the better quality or greater quantity of work shall be provided.
- B. Feeders, Branch Circuits and System Conduits:
1. Underground and In or Below Concrete: RMC, RNMC.
  2. Above Slab or Grade:
    - a. Exposed Conduit Below 10'-0" AFF: RMC or IMC where subject to physical damage. EMT where not subject to physical damage.
    - b. Exposed Conduit Above 10'-0" AFF: EMT.
    - c. Concealed In Walls: EMT.
    - d. Concealed Above Ceiling: EMT.
    - e. Hazardous Locations: RMC.
    - f. Exposed Conduit Serving Roof Mounted Equipment: RMC, EMT.
    - g. Wet Locations: RMC.
- C. Data/communications conduits in dry locations not subject to physical damage and not installed underground nor in or below concrete: EMT.
1. Data/communication conduits shall be bonded.
  2. Data/communication sleeves, provide plastic bushings.
  3. Data/communication conduits shall be 3/4-inch minimum.
- D. Lighting Fixture Support: RMC.
1. Light fixtures shall not be supported via standard locknuts at the fixture connection. Provide fittings with set-screw or other means to prevent loosening.
  2. Hands-free swivel type hangers shall be used in dry locations. Threaded conduit fittings shall be used in Damp, Wet, Corrosive, and Hazardous Locations.
- E. Connection To Equipment:
1. Lighting Fixtures and Control Devices:
    - a. Dry Locations: FMC.
    - b. Wet or Damp Locations: LTFMC.
  2. Vibrating Equipment (including, but not necessarily limited to motors and transformers):
    - a. Motors:
      - 1) Dry Locations: FMC.
      - 2) Wet or Damp Locations: LTFMC.
    - b. Transformers:
      - 1) Dry Locations: FMC.
      - 2) Wet or Damp Locations: LTFMC.
    - c. Equipment Mounted On Vibration Isolators:
      - 1) Dry Locations: FMC.
      - 2) Wet or Damp Locations: LTFMC.

- F. Provide separate raceway systems for:
  - 1. Normal power wiring.
  - 2. Emergency power wiring.
  - 3. Data/communication wiring.
  - 4. Fire alarm system wiring.
  - 5. A.C. signal and control wiring.
  - 6. Low voltage signal and control wiring.
  - 7. Analog instrumentation wiring.
  - 8. Special systems wiring.
  
- G. Do not utilize panelboards, motor control centers, distribution equipment or like devices as raceways.
  
- H. Provide innerduct in each conduit run that contains fiber optic cable. Conduit that contains innerduct and fiber optic cable shall not be routed through Hazardous Locations without approval from the Engineer.
  
- I. For conduits that enter NEMA Type 2, 3, 3R, 4, 4X, and 12 enclosures, provide conduit hubs with o-ring gaskets. Hubs shall be suitable for the environment served and shall match the conduit type. Grounding hubs shall be used with nonmetallic enclosures.

END OF SECTION 26 05 34

## SECTION 26 05 35 – 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.

#### 1.2 SUMMARY

- A. This Section includes the furnishing and installation of all electrical boxes and the major items listed below:
  - 1. Outlet boxes.
  - 2. Junction boxes.
  - 3. Pull boxes.

#### 1.3 REFERENCES

- A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with the following:
  - 1. NEMA - National Electrical Manufacturer's Association: Standards as applicable to nonmetallic fittings for underground installation.
  - 2. NECA - National Electrical Contractor's Association's: Applicable portions of "Standard of Installation".

#### 1.4 QUALITY ASSURANCE

- A. Fabrication and Installation Personnel Qualifications:
  - 1. Trained and experienced in the fabrication and installation of the materials and equipment.
  - 2. Knowledgeable of the design and the reviewed submittals.
- B. Regulatory Agencies Requirements:
  - 1. Provide boxes which are listed and labeled by Underwriters' Laboratories.
  - 2. NEC - National Electrical Code (NFPA 70) - As applicable to construction and installation of electrical boxes.

#### 1.5 DELIVERY, STORAGE AND HANDLING

- A. Deliver all materials in original, unbroken, brand marked containers or wrapping as applicable.
- B. Handle and store materials in a manner which will prevent deterioration or damage, contamination with foreign matter, damage by weather or elements, and in accordance with Manufacturer's directions.
- C. Store materials indoors and protect from weather. When necessary to store outdoors, elevate materials above grade and enclose with durable, watertight wrapping.
- D. Reject damaged, deteriorated, or contaminated materials and immediately remove from the Site. Replace rejected materials with new materials at no additional cost to Owner.

### PART 2 - PRODUCTS

#### 2.1 MATERIALS

- A. Interior Outlet Boxes:
  - 1. Galvanized steel outlet boxes of the type, shape, and size, including depth of box, to suit each respective location and installation; constructed with stamped knockouts in back and sides, and with threaded holes with screws for securing box covers or wiring devices.
  - 2. In areas requiring exposed RNMC, provide nonmetallic outlet boxes of type, shape and size to suit each location. Each box is to have conduit hubs with removable plugs and a non-metallic cover. Each box shall be compatible with RNMC.

- B. Interior Outlet Box Accessories:
  - 1. As required for each installation, including mounting brackets, wallboard hangers, extension rings, fixture studs, cable clamps, and metal straps for supporting outlet boxes. Accessories shall be compatible with outlet boxes being used and meet the requirements of individual wiring situations.
  - 2. Choice of accessories is installer's option.
- C. Weatherproof Outlet Boxes: Corrosion-resistant cast metal, weatherproof outlet boxes, of the type, shape, and size, including depth of box, suitable for each application, with threaded conduit ends.
- D. For Ceilings: 4-inch octagonal boxes for receiving 3 or less 1/2-inch conduits.
- E. For Flush Mounting In Walls:
  - 1. 4-inch square boxes with matching plaster cover for single or 2 gang outlets.
  - 2. For larger boxes use solid type or special units.
  - 3. In masonry, use deep boxes.
- F. Surface Mounted: 4-inch square.
- G. Junction and Pull Boxes: Sheet steel junction and pull boxes, with screw-on covers; of the type and shape and size to suit each respective location and installation; with welded seams and equipped with stainless steel nuts, bolts, screws, and washers. Dry interior location boxes shall have baked enamel finish. Damp location and exterior boxes shall have galvanized finish.
- H. Flush Mounted Pull Boxes: Provide overlapping covers with flush-head cover retaining screws, prime coated.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. General:
  - 1. Install electrical boxes as indicated, in compliance with NEC requirements and in accordance with the Manufacturer's written instructions and recognized industry practices to ensure that the boxes and fittings serve the intended purposes.
  - 2. Provide weatherproof outlet boxes for interior and exterior locations exposed to weather or moisture.
  - 3. Provide knockout closures to cap unused knockout holes where blanks have been removed.
  - 4. Locate boxes and conduit bodies so as to ensure accessibility of electrical wiring.
  - 5. Secure boxes rigidly to the substrate upon which they are being mounted, or solidly embed boxes in concrete or masonry.
  - 6. Mount outlet boxes flush in areas other than mechanical rooms, electrical rooms, and above removable ceilings.
  - 7. Adjust position of outlets in finished masonry walls to suit masonry course lines.
  - 8. Do not install boxes back-to-back in same wall. Coordinate cutting of masonry walls to achieve neat openings for boxes.
  - 9. Do not use sectional or handy boxes unless specifically requested.
  - 10. For boxes mounted in exterior walls install insulation behind outlet boxes to prevent condensation in boxes.
  - 11. For outlets mounted above counters, benches, and splashbacks, coordinate location and mounting heights with built-in units. Adjust outlet mounting height to agree with required location for equipment served.
  - 12. Outlet boxes in finished areas shall be located as indicated on the Drawings and so set that the face plates will be flush with the finish on which it is mounted. Where 2 or more devices of any kind are set side by side, set them in gang boxes unless otherwise noted on the Drawings.
  - 13. Locate pull boxes and junction boxes above removable ceilings or in electrical rooms, utility rooms, or storage areas such that boxes will be accessible after completion of building.
  - 14. All boxes shall have covers installed at completion of construction.

END OF SECTION 26 05 35



## SECTION 26 05 36 – 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.

#### 1.2 SUMMARY

- A. This Section includes the furnishing and installation of steel cable trays, support system, wall penetration assemblies, and accessories.

#### 1.3 SUBMITTALS

- A. Shop Drawings: For cable tray.
  - 1. Name of Manufacturer.
  - 2. Model numbers.
  - 3. Details of construction and installation.
  - 4. Equipment specifications and ratings.
  - 5. Dimensional data.
  - 6. Weight.
  - 7. Color and finish.
  - 8. Bill of materials.
  - 9. Options and accessories.
- B. Layout Drawings: For cable tray. Plans shall be to scale and identify routing information, mounting elevations, support locations, and wall/floor penetrations.
- C. Cable tray sizing calculations.
- D. Installation instructions for cable tray.

#### 1.4 QUALITY ASSURANCE

- A. Fabrication and Installation Personnel Qualifications:
  - 1. Trained and experienced in the fabrication and installation of the materials and equipment.
  - 2. Knowledgeable of the design and the reviewed submittals.
- B. Regulatory Agencies Requirements:
  - 1. Comply with applicable requirements of NEMA standards pertaining to raceways.
  - 2. Comply with provisions of UL safety standards pertaining to electrical conduit systems.
  - 3. All products and components shall be UL listed and labeled.
  - 4. Comply with the NEC requirements as applicable to construction and installation of cable tray systems.

#### 1.5 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials in original, unbroken, brand marked containers or wrapping as applicable.
- B. Handle and store materials in a manner which will prevent deterioration or damage (e.g., bending, end damage, finish scoring), contamination with foreign matter, damage by weather or elements, and in accordance with Manufacturer's directions.
- C. Store materials indoors and protect from weather. When necessary to store outdoors, elevate materials above grade and enclose with durable, watertight wrapping.

- D. Reject damaged, deteriorated, or contaminated materials and immediately remove from the Site. Replace rejected materials with new materials at no additional cost to Owner.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Cable Tray, Fittings and Accessories:
  - 1. B-Line Systems, Inc.
  - 2. Chalfant Cable Trays.
  - 3. GS Metals Corp.
  - 4. Mono-Systems, Inc.
  - 5. MPHusky.
  - 6. P-W Industries, Inc.
  - 7. Thomas & Betts Corporation.
  - 8. Cope-Glas.
  - 9. Or equal.

### 2.2 MATERIALS AND FINISHES

- A. Cable trays, fittings and accessories shall be steel, with the following finish:
  - 1. Mill galvanized before fabrication, complying with ASTM A653/A653M, G90 coating.
- B. Protect steel hardware against corrosion by galvanizing according to ASTM B633 or cadmium plating according to ASTM B766.
- C. Fabricate cable tray products with rounded edges and smooth surfaces.
- D. Sizes and Configuration: Refer to the Drawings for specific requirements for types, materials, sizes, and configurations.

### 2.3 CABLE TRAY ACCESSORIES

- A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.
- B. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray Manufacturer.
- C. Wall penetration assemblies shall consist of 3 basic components: Galvanized steel frame, sponge rubber pads and sealant.
  - 1. Frames shall be attached to the wall to hold other components in place. Frames shall be able to be opened and closed repeatedly to allow for cable maintenance and additions.
  - 2. Sponge rubber pads shall be compressed around the penetrating items. Pads shall be able to be easily cut to fit around large cables, cable trays or ducting. Sponge shall provide a structural backing for the sealant.
  - 3. Sealant shall be a highly elastomeric silicon compound. Sealant shall be applied to the outer edge of the units. Sealant shall provide a water-and chemical-resistant barrier.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install cable tray products in accordance with:
  - 1. The Drawings.
  - 2. Manufacturer's written instructions.
  - 3. Applicable requirements of NEC and National Electrical Contractors Association's "Standard of Installation".
  - 4. Recognized industry practices to ensure that products serve intended function.

- B. Support cable tray in accordance with:
  - 1. Division 26 Section "Hangers and Supports for Electrical Systems."
  - 2. The NEC.
- C. Coordinate installation with other trades.
- D. Firestopping: Firestop all cable tray penetrations of fire rated barriers using approved material to ensure integrity of the rating.

END OF SECTION 26 05 36

## SECTION 26 05 53 – 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.

#### 1.2 SUMMARY

- A. This Section includes the furnishing and installation of proper identification for electrical system components.
- B. Items requiring identification or labeling include:
  - 1. Cables and conductors.
  - 2. Conduit systems.
  - 3. Controls:
    - a. Motor starters.
  - 4. Distribution Equipment:
    - a. Disconnect switches.
    - b. Enclosed circuit breakers.
    - c. Transformers.
    - d. Panelboards.
  - 5. High voltage equipment.
  - 6. Fire alarm system equipment.

#### 1.3 SUBMITTALS

- A. Nameplate schedule identifying each device to be labeled and project specific label text.

### PART 2 - PRODUCTS

#### 2.1 ELECTRICAL LABELS

- A. Provide engraved laminated plastic nameplate to identify each piece of electrical equipment:
  - 1. Nameplate shall have 3/8-inch minimum black letters on a white background.
  - 2. Punched or drilled for mechanical fasteners.
- B. Provide printed labels by Brady or T&B to identify conductors.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. General:
  - 1. Attach nameplates directly to each piece of electrical equipment. In finished areas of building, install nameplates behind enclosure door where possible.
  - 2. Where several conductors pass through a pull box, junction box, or enclosure, provide wire labels. Group wires before labeling.
- B. Cables and Conductors:
  - 1. Cables and conductors shall be color-coded in accordance with Division 26 Section "Conductors and Cables – 600V and Below."
  - 2. All conductors and cables for power, lighting, control, supervision, low voltage systems, etc. shall be labeled with the source and circuit number and/or match the identification provided in the manufacturer's submittals and O&M manuals. If none of the identifiers are suitable or available, the Contractor shall devise a clear and understandable identification labeling system. Without exception, all cables and conductors shall be clearly labeled.
  - 3. Labeling shall occur everywhere cables and conductors are terminated or spliced.

- C. Conduit Systems:
1. Junction boxes used for fire alarm system wiring shall be red.
  2. Provide label inside each junction and pull box identifying circuit numbers for all conductors contained inside the box. Labeling shall be printed neatly with permanent, waterproof, black ink marker.
- D. Controls: For each of the following control devices, provide label attached to enclosure cover. Label shall identify:
1. Motor Starters: Name of equipment served and load (example, "EF-5, 5 HP").
- E. Distribution Equipment: For each of the following pieces of electrical distribution equipment, provide label attached to enclosure cover. Label shall identify:
1. Disconnect Switches: Name of equipment served, number of poles, ampere rating/fuse size (where applicable), and load (example, "RTU-1, 3P30/25, 8 TON").
  2. Enclosed Circuit Breakers: Name of device as indicated on one line diagram, number of poles, and circuit breaker size (example, "MCB, 3P200").
  3. Transformers: Name of electrical equipment as indicated on one line diagram, KVA rating, primary voltage:secondary voltage, source transformer is fed from, and load transformer feeds (example, "T-LPA, 45 KVA, 480:208Y/120V, FED FROM MSWBD, FEEDS PANEL LPA").
  4. Panelboards:
    - a. Name of electrical equipment as indicated on one line diagram, voltage-phase, and source panelboard is fed from (examples, "LPA, 208Y/120V-3Ø-4 WIRE, FED FROM T-LPA"; "DPA, 480Y/277V-3Ø-4 WIRE, FED FROM MSWBD").
    - b. Equip interior of enclosure door with a circuit directory frame, typewritten card, and clear plastic cover. Directory shall identify load description for each circuit, including spares. Hand lettering is not acceptable.
- F. Fire Alarm System Equipment: Provide label attached to enclosure cover. Label shall identify name of device as indicated on fire alarm system riser diagram or electrical drawings (example, "FIRE ALARM CONTROL PANEL").

END OF SECTION 26 05 53

## SECTION 26 05 73 – OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY AND ARC FLASH RISK ASSESSMENT

### 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 requirements for performing a computer-based, short circuit and protective device evaluation, coordination study, and arc flash risk assessment.

#### 1.3 REFERENCES

- A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with the following:
  1. NFPA 70 – National Electrical Code.
  2. NFPA 70E – Standard for Electrical Safety in the Workplace.
  3. IEEE 1584 – Guide for Performing Arc Flash Hazard Calculations.

#### 1.4 SUBMITTALS

- A. Product Data: For computer software program to be used for studies.
- B. The Contractor shall retain Shermco to prepare the Arc Flash Calculations and labeling. The contact is Ryan Broderick. The electrical contractor shall be responsible for providing Shermco with conductor lengths and sizes, transformer impedances, etc. so that Shermco can prepare the study. Any setting adjustments shall be performed by the electrical Contractor.

#### 1.5 DATA COLLECTION FOR SHORT CIRCUIT AND PROTECTIVE DEVICE EVALUATION, COORDINATION STUDY, AND ARC FLASH RISK ASSESSMENT

- A. Contractor Responsibilities: Provide all required data for preparation of the short circuit and protective device evaluation, coordination of study, and arc flash risk assessment. Field verify existing distribution system to obtain all required data.
- B. Subcontractor Responsibilities: Provide a listing of all required data necessary to perform the short circuit and protective device evaluation, coordination study, and arc flash risk assessment immediately after award of the Contract.

### PART 2 - PRODUCTS

Not used.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. The Contractor shall install arc flash hazard warning labels on all electrical equipment, included in the Study, with all the required information indicated herein.
- B. Contractor shall perform field adjustments of protective devices and replace fuses as required to place the equipment in final operating condition. Settings for protective devices, fuse types and fuse sizes shall be in accordance with the recommendations of the reviewed coordination study.

END OF SECTION 26 05 73

## SECTION 26 08 13 – ELECTRICAL TESTING

### 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 electrical testing.

#### 1.3 REFERENCES

- A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with the following:
  1. NFPA 70 – National Electrical Code.
  2. NFPA 70E – Standard for Electrical Safety in the Workplace.
  3. InterNational Electrical Testing Association (NETA) – Standard for Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems, ANSI/NETA ATS-(Latest Edition).
  4. IEEE - Institute of Electrical and Electronics Engineers.

#### 1.4 SUBMITTALS

- A. Within 30 days after Notice to Proceed, submit certification of the qualifications of the Electrical Testing Firm (ETF).
- B. Within 30 days after Notice to Proceed, submit a complete project-specific list (based on project-specific nomenclature), of all equipment to be tested and the descriptions of the tests to be performed, for approval.
- C. For items to be tested, a test report shall be generated for each piece of electrical equipment, device, installation and system as indicated in the Specifications and shall include the following:
  1. Check list of visual and mechanical inspections.
  2. Check list of electrical tests performed.
  3. Test reports, including test values where applicable, for all required electrical tests.
  4. Obvious indication on the first page of the test report, where test results fall outside of the limits of recommended values.
  5. Summary and interpretation of test results.
    - a. Describe the problem in detail.
    - b. Offer suggestions for correction or potential solution.
  6. Signed and dated by the testing firm stating that all required tests have been completed.
- D. Test reports shall be furnished to the Architect/Engineer within 14 days of completion of each test on an ongoing basis for approval. Final copies of the approved reports shall be included in the Contractor's Operation and Maintenance (O&M) Manual.
- E. Submit a final report of testing and inspection at the completion of the project. Include the following:
  1. Summary of the project.
  2. Description of the equipment tested (based on project-specific nomenclature for all applicable equipment).
  3. Visual and mechanical inspection report for each piece of equipment.
    - a. Report shall include a clear statement or verbiage that all visual and mechanical inspections have been performed in accordance with the NETA guidelines for all equipment and or items listed in the approved Submittal of a project specific list indicated in paragraph 1.4 B.
  4. Description of the NETA required electrical tests.

5. Test results as described in the latest edition of NETA.
  - a. Include a pass or fail grade as compared to the reference tables provided in ANSI/NETA ATS- (Latest Edition) and industry standards for all individual tests.
  - b. Report shall include all test results. This includes all failed tests and retests.
  - c. Infrared report shall include all pictures taken of all equipment, not just equipment with issues. If issues are found, the report shall include a picture of the issue and a picture after the problem has been resolved.
6. Conclusions and recommendations.
7. Appendix including appropriate test forms.
8. Identification of the test equipment used, including model number, and calibration date.
9. Signature of test engineer.

#### 1.5 QUALITY ASSURANCE

- A. The ETF shall be the installing contractor.
- B. The ETF shall function as an unbiased testing authority, professionally independent of the manufacturers, suppliers, and installers of equipment or systems evaluated by the testing firm unless the ETF indicated above allows the installing contractor to perform the testing.
- C. The ETF shall be regularly engaged for minimum of 5 years in testing of electrical materials, devices, electrical installations, and systems for purpose of preventing injury to persons or damage to property and other equipment
- D. The ETF shall have successfully completed not less than 5 acceptance testing, inspection and calibration projects of similar scope to this Project.
- E. The ETF shall meet OSHA criteria for accreditation of testing laboratories, 29 CFR Parts 1907, 1910, and 1936, or be a Full Member company of NETA (unless paragraph 1.5 A allows the installing contractor to perform the testing).
- F. The ETF lead, on-site, technical person shall be currently certified by NETA or National Institute for Certification in Engineering Technologies (NICET) in electrical power distribution system testing, unless paragraph 1.5 A allows the installing contractor to perform the testing.
- G. The ETF shall only utilize engineers and technicians who are regularly employed by the firm for testing services.
- H. The ETF shall have a calibration program to maintain applicable test instrumentation within rated accuracy. Accuracy shall be traceable to National Institute of Standards and Technology (NIST) in an unbroken chain. Instruments shall be calibrated as follows:
  1. Field Instruments: 6 months maximum.
  2. Laboratory Instruments: 12 months maximum.
  3. Specialty Leased Equipment: 12 months maximum.
  4. Dated calibration labels shall be visible on test equipment.
- I. Submit certification of the above qualifications; refer to the SUBMITTALS Paragraph of this Section.

#### PART 2 - PRODUCTS

Not used.

#### PART 3 - EXECUTION

##### 3.1 VISUAL INSPECTIONS

- A. The ETF shall perform all visual and mechanical inspections in accordance with ANSI/NETA ATS-(Latest Edition) "Testing and Test Procedures" chapters in addition to the list below for all applicable electrical equipment to be installed at the Site.



- B. The ETF prior to testing, shall perform the following visual and mechanical inspections (in addition to the NETA requirements listed above):
  - 1. The equipment is installed in accordance with manufacturer's installation instructions and the current National Electrical Code (NEC).
  - 2. The equipment is installed completely and properly.
  - 3. The equipment is free from damage and defects.
  - 4. Shipping blocks and restraints have been removed.
  - 5. Electrical terminations have been properly torqued to manufacturer's recommendations and torque marks applied.
  - 6. The equipment has been properly aligned.
  - 7. The equipment has been properly lubricated.
  - 8. The ventilation louvers are open and unobstructed.
  - 9. The equipment is ready to be tested.

### 3.2 TEST PROCEDURES

- A. Many electrical tests will need to be performed prior to making terminations and connections and ahead of system start-up. The electrical contractor is required to coordinate this work with all parties involved to avoid delays in construction or obtaining permanent power.
- B. The ETF shall perform all test procedures on-site, no exceptions allowed. It will not be acceptable to remove equipment or components and ship items off-site to be tested then ship items back to the site to be reinstalled.
- C. All disassembly and reassembly of equipment for testing purposes shall be performed or witnessed by the approved testing agency.
- D. The ETF shall perform test procedures in accordance ANSI/NETA ATS-(Latest Edition) "Inspection and Test Procedures" chapters (see list below; not all may be applicable for this project) for all applicable electrical equipment to be installed at the Site.
  - 1. 7. INSPECTION AND TEST PROCEDURES.
    - a. 7.2.1.1 Transformers, Dry-Type, Air-Cooled, Low-Voltage, Small. Test all dry type transformers 75kVA and above.
    - b. 7.3.2 Cables, Low-Voltage, 600-Volt Maximum. Test all cables 100A and above.
    - c. 7.4 Metal-Enclosed Busways.
    - d. 7.5.1.1 Switches, Air, Low-Voltage.
    - e. 7.16.1.1 Motor Control, Motor Starters, Low-Voltage.

### 3.3 CORRECTION ACTION

- A. Equipment that fails a test shall be repaired or replaced as needed and retested. Both the failed test and the passing test shall be submitted for approval and included in the contractors O&M Manual. For failed test, add note to refer to follow-up test.

END OF SECTION 26 08 13

## SECTION 26 09 23 – 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.

#### 1.2 SUMMARY

- A. This Section includes the furnishing and installation of all lighting control devices listed below:
  - 1. Occupancy sensors (wall and ceiling mounted) and related power packs.

#### 1.3 SUBMITTALS

- A. Shop Drawings: Provide the following information for each type of lighting control device.
  - 1. Name of Manufacturer.
  - 2. Model number.
  - 3. Details of construction and installation.
  - 4. Assembly drawings, including elevations, plans, sections, and dimensions.
  - 5. Project Specific Point-To-Point Wiring Diagrams:
    - a. Diagrams shall clearly identify all field wiring requirements.
    - b. Connection points shall be identified by terminal number.
  - 6. Project specific floor plans, including all occupancy sensor types and locations as recommended by Manufacturer.
  - 7. Color and finish.
  - 8. Options and accessories.
- B. Installation Instructions: For lighting control devices.
- C. Installation and Maintenance Manuals: For lighting control devices.
  - 1. Equipment function, normal operating characteristics, and limiting conditions.
  - 2. Assembly, installation, alignment, adjustment, and checking instructions.
  - 3. Operating instructions for start-up, routine and normal operating, regulation and control, shutdown, and emergency conditions.
  - 4. Maintenance instructions.
  - 5. Guide to “troubleshooting.”
  - 6. Parts list and predicted life of parts subject to wear.
  - 7. Project specific outline and cross-sections, assembly drawings, engineering data, and wiring diagrams. Wiring diagrams shall reflect final, as-installed conditions and include wire numbers.
  - 8. Test data and performance curves.

#### 1.4 QUALITY ASSURANCE

- A. Fabrication and Installation Personnel Qualifications:
  - 1. Trained and experienced in the fabrication and installation of the materials and equipment.
  - 2. Knowledgeable of the design and the reviewed submittals.
- B. Manufacturer:
  - 1. At least 5 years experience with approved systems.
  - 2. Provide Owner training on system operation.
- C. Components: All equipment shall be UL listed.

#### 1.5 WARRANTY

- A. In accordance with the warranty provisions defined in the General Conditions and Supplementary Conditions: Includes all lighting control systems.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver all materials in original, unbroken, brand marked containers or wrapping as applicable.
- B. Handle and store materials in a manner which will prevent deterioration or damage, contamination with foreign matter, damage by weather or elements, and in accordance with Manufacturer's directions.
- C. Store materials indoors and protect from weather.
- D. Reject damaged, deteriorated, or contaminated materials and immediately remove from the Site. Replace rejected material with new material at no additional cost to Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Occupancy Sensors:
  - 1. Acuity - nLight.
  - 2. Leviton.
  - 3. Wattstopper.
  - 4. Hubbell.
  - 5. All occupancy sensors shall be produced by the same Manufacturer.

2.2 MATERIALS

- A. General: Furnish and install lighting control devices as indicated on the Drawings.
- B. Low Voltage Wiring:
  - 1. For low voltage wiring, provide wire type as recommended by the Manufacturer.
  - 2. Adhere to manufacturer's recommendations as to maximum wire length and maximum quantity of relays per switch.
- C. Line Voltage Wiring: No. 12 AWG minimum.
- D. Occupancy Sensors:
  - 1. Provide occupancy sensors as indicated herein and on the Drawings.
  - 2. System Components:
    - a. Ultrasonic occupancy sensors.
    - b. Passive infrared occupancy sensors.
    - c. Dual technology occupancy sensors.
    - d. All Occupancy Sensors Shall Include:
      - 1) Self adjusting type based on algorithm for maximum performance.
      - 2) Adjustable unit sensitivity.
      - 3) UL and CBA listed.
      - 4) Five year warranty.
      - 5) Mounting brackets or boxes as required for each space application.
    - e. Each Ceiling Mounted Sensor Shall Include:
      - 1) Power pack.
      - 2) Isolated relay contact.
      - 3) Manual off override if indicated.
      - 4) LED indicates motion detection.
    - f. Device quantities and locations as indicated on the Drawings.
    - g. Wiring: As indicated on the Drawings.
- E. Timeclock:
  - 1. Provide programmable 7-day time clock capable of maintaining schedule with the following features.
    - a. Electronic.
    - b. Astronomical.
    - c. Timer automatically adjusts to correct time after power outage.

- d. Local manual override switch.
- e. Self adjusting timer for seasonal changes.
- f. Battery back-up to maintain time control and schedule.
- g. Enclosure type shall be NEMA 1.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. General:
  - 1. Install lighting control devices as indicated on the Drawings.
  - 2. Install all lighting control devices in accordance with Manufacturer's recommendations.

#### 3.2 FIELD QUALITY CONTROL

- A. Contractor Field Service: Provide qualified personnel to perform, schedule and coordinate the following work:
  - 1. Before beginning work, contact Owner's Building Automation System Contractor to review system requirements.
  - 2. Coordinate all work with Owner's Building Automation System Contractor. Communicate any wiring revisions made in the field.
  - 3. Install all wiring, override switches, lighting control panels and contactors as indicated on Drawings.
  - 4. Terminate and label all wiring.
  - 5. Provide labels for all override switches, lighting control panels, and contactors.
- B. Assist Owner's Building Automation System Contractor in start-up:
  - 1. Inspect equipment for signs of damage.
  - 2. Verify installation is in accordance with Drawings.
  - 3. Test all devices to be certain system will function properly.
  - 4. Demonstrate operation and maintenance to Owner's personnel.
  - 5. Provide 2 hour training sessions to Owner's personnel during each Site visit.
  - 6. Correct any deficiencies and make adjustments as required.
  - 7. Provide 2 separate Site visits for start-up. Schedule and coordinate date with Owner's Building Automation System Contractor. Each Site visit shall be a minimum of 4 hours for the following:
    - a. Site Visit No. 1 shall occur for system start-up.
    - b. Site Visit No. 2 shall occur 3 to 4 months after Substantial Completion for final adjustments and additional training.

#### 3.3 CLEANING

- A. Clean all lighting control system devices at Substantial Completion.

#### 3.4 ADJUSTING

- A. Set time delay and sensitivity for all occupancy sensors in accordance with Manufacturer's written instructions based on room type.
- B. Program time clocks with input from Owner.

END OF SECTION 26 09 23

## SECTION 26 22 13 – LOW VOLTAGE DISTRIBUTION 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.

#### 1.2 SUMMARY

- A. This Section includes the furnishing and installation of all transformers.

#### 1.3 REFERENCES

- A. Except as herein specified, or as indicated on the Drawings, the work of this Section shall comply with the following:
  - 1. NEMA (National Electrical Manufacturers Association) Standards:
    - a. ANSI/NEMA ST20 - Dry-Type Transformers for General Applications.
    - b. ANSI/NEMA TR27 - Commercial, Institutional and Industrial Dry-Type Transformers.
  - 2. DOE (Department of Energy): 2016 Efficiency Standards.

#### 1.4 SYSTEM DESCRIPTION

- A. General: Transformers as defined for this Section include all air-cooled, dry-type equipment:
  - 1. 600 volt and below.
  - 2. Single-phase and 3-phase.
- B. Design and Performance Requirements:
  - 1. Sound Levels:
    - a. Not to exceed NEMA standards.
    - b. Manufacturer certified for all units furnished.

#### 1.5 SUBMITTALS

- A. Shop Drawings: For transformers.
  - 1. Name of Manufacturer.
  - 2. Model number.
  - 3. Details of construction and installation.
  - 4. Assembly drawings, including elevations, plans, sections, dimensions, weight, and conduit entry locations.
  - 5. Mounting configuration.
  - 6. Electrical Ratings:
    - a. KVA.
    - b. Primary and secondary voltages.
    - c. Impedance.
    - d. Temperature rise.
  - 7. Options and accessories.
  - 8. Color and finish.
- B. Installation instructions for transformers.

#### 1.6 QUALITY ASSURANCE

- A. Fabrication and Installation Personnel Qualifications:
  - 1. Trained and experienced in the fabrication and installation of the materials and equipment.
  - 2. Knowledgeable of the design and the reviewed submittals.

- B. Regulatory Agencies Requirements:
  - 1. All transformers shall carry the Underwriters' Laboratory label.
  - 2. Single phase transformers, 167 KVA and smaller, and 3 phase transformers 500 KVA and smaller shall be UL listed and labeled.

#### 1.7 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials in original, unbroken, brand marked containers or wrapping as applicable.
- B. Handle and store materials in a manner which will prevent deterioration or damage, contamination with foreign matter, damage by weather or elements, and in accordance with Manufacturer's directions.
- C. Store materials indoors in a controlled environment with low moisture content. Do not store outdoors.
- D. Reject damaged, deteriorated, or contaminated materials and immediately remove from the Site. Replace rejected materials with new materials at no additional cost to Owner.

#### 1.8 PROJECT CONDITIONS

- A. Provide temporary temperature/humidity control:
  - 1. For all installed, non-energized transformers.
  - 2. In a manner which will maintain atmospheric moisture content inside the transformers at an acceptable minimum.

#### 1.9 WARRANTY

- A. Manufacturer shall furnish for all transformers: 2-year unconditional warranty.
  - 1. Beginning on date of delivery to Contractor.
  - 2. Contingent on Manufacturer approved installation.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Provide products produced by the following Manufacturer:
  - 1. Schneider Electric; Square D Products.
  - 2. No exceptions.

#### 2.2 TRANSFORMERS

- A. Voltage and phase as indicated on the Drawings.
- B. Voltage Taps:
  - 1. Single Phase: Four 2-1/2% FCBN.
  - 2. Three Phase: Two 2-1/2% FCAN and four 2-1/2% FCBN.
- C. Insulation:
  - 1. An UL recognized 220 degrees C insulating system, operating at 80 degrees C rise over an ambient of 40 degrees C.
  - 2. Transformers shall have the ability to carry a 30% overload at rated voltage without exceeding this rating.
- D. Vibration: Completely isolate the core and coil unit from the enclosure by means of vibration absorbing mounts.
- E. Ground Lugs: Supply transformers with external ground lugs internally connected to transformer neutral.

- F. Cores:
  - 1. Construct cores of nonaging, high-permeability, grain-oriented, cold-rolled silicon steel.
  - 2. Minimum acceptable steel grade: Electrical steel graded M-6.
  - 3. Keep magnetic flux densities well below the saturation point, and in no case shall these exceed a design level of 14.8 Kilogauss, for units K-rated.
  - 4. The core shall not saturate even when the transformer is subjected to 120% of nameplate voltage.
  - 5. Clamp core with structural angle and bolt to the enclosure to prevent damage during shipment.
- G. Coils: Wound of continuous aluminum or copper conductors without splices.
- H. Impregnation:
  - 1. Thoroughly dry core and coil with core brackets.
  - 2. Impregnate with a minimum of two complete cycles of a silicone varnish.
  - 3. Complete with 1 finishing coat of a high temperature sealer varnish.
- I. Enclosure:
  - 1. Degrease, clean, phosphatize, and prime entire transformer enclosure.
  - 2. Finish with baked enamel.
  - 3. Air dry finish will not be accepted as being equal.
- J. Terminal Compartments:
  - 1. Readily accessible with clamp type terminals sturdily mounted.
  - 2. Size all wiring compartment covers so that when removed the entire wiring compartment area is exposed.
- K. Core Mounting: Mount core and coil of all cabinet type transformers above the base in order to provide space at the bottom of the transformer enclosure so that wiring is never exposed to temperatures higher than the ambient temperature.
- L. Grounding: Ground core and coil assembly to the enclosure with flexible copper strap.
- M. Nameplates: Permanently attach metal nameplates, marked in accordance with NEMA specifications, to the transformer in a readily accessible position.
- N. Case Temperature: The maximum top or case temperature at full load shall not exceed 35 degrees C above ambient.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Mounting: Mount all transformers as indicated on the Drawings.
- B. Equipment Grounding: Provide transformer enclosure equipment grounding in accordance with the latest applicable edition of the National Electrical Code.
- C. Neutral Conductor Grounding:
  - 1. Provide a THW insulated grounding conductor from the neutral of a Wye connected secondary 3 phase transformer or the secondary center tap of a single phase transformer to the nearest acceptable grounding electrode.
  - 2. This work shall be in accordance with the latest applicable edition of the National Electrical Code.
- D. Install transformers in accordance with Manufacturer's recommendations.
- E. Technical Literature: Turn over all technical literature and Manufacturer's guarantee to Owner and obtain a signed receipt.

3.2 ADJUSTING

- A. Adjust the full capacity taps under no load so that the average secondary phase to neutral voltage for the 3-phases is as close as possible to 120 volts.

3.3 CLEANING

- A. Shipping Protection: Remove all shipping and packing protection, include core clamps.
- B. Cleaning: Clean interior and exterior of transformers and leave them free of dust and particles that accumulate during construction prior to turning system over to Owner.

END OF SECTION 26 22 13



## SECTION 26 24 16 – 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.

#### 1.2 SUMMARY

- A. This Section includes the furnishing and installation of all distribution panelboards, and lighting and appliance branch-circuit panelboards.
- B. Division of Work:
  - 1. In accordance with the General Conditions, be responsible for dividing the Work among the Subcontractors and Suppliers and for delineating the work to be performed by specific trades.
  - 2. The following are suggestions as to how the Work may be divided. This is not a complete list of all the work:
    - a. General Contractor:
      - 1) Install concrete pads:
        - a) As specified herein.
        - b) As directed by Electrical Subcontractor.
    - b. Electrical Subcontractor:
      - 1) Arrange and pay for all concrete pads.
      - 2) Coordinate pad location with General Contractor.

#### 1.3 SUBMITTALS

- A. Product Data: For each type of panelboard.
  - 1. Include name of manufacturer and model numbers.
  - 2. Include materials, switching and overcurrent protective devices, SPDs, accessories and components indicated.
  - 3. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings and finishes.
- B. Shop Drawings: For each panelboard and related equipment.
  - 1. Name of Manufacturer.
  - 2. Model number.
  - 3. Details of construction and installation.
  - 4. Project specific assembly drawings, including elevations, plans, sections, dimensions, weight, and conduit entry locations.
  - 5. Project specific electrical ratings:
    - a. Voltage.
    - b. Amperage.
    - c. Short-circuit current rating of panelboards and overcurrent protective devices.
  - 6. Project specific enclosure types.
    - a. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges and locks.
  - 7. Project specific color and finish.
  - 8. Project specific one line diagram.
  - 9. Project specific options and accessories.
- C. Installation Instructions: For panelboards.
- D. Operation and Maintenance Manuals: For panelboards.
  - 1. Equipment function, normal operating characteristics, and limiting conditions.
  - 2. Assembly, installation, alignment, adjustment, and checking instructions.

3. Operating instructions for start-up, routine and normal operating, regulation and control, shutdown, and emergency conditions.
4. Maintenance instructions.
5. Guide to "troubleshooting."
6. Parts list and predicted life of parts subject to wear.
7. Project specific outline and cross sections, assembly drawings, engineering data, and wiring diagrams.
8. Test data and performance curves.

#### 1.4 QUALITY ASSURANCE

- A. Fabrication and Installation Personnel Qualifications:
  1. Trained and experienced in the fabrication and installation of the materials and equipment.
  2. Knowledgeable of the design and the reviewed submittals.
- B. All panelboards and accessories shall bear the UL label.

#### 1.5 DELIVERY, STORAGE AND HANDLING

- A. Deliver all materials in original, unbroken, brand marked containers or wrapping as applicable.
- B. Handle and store materials in a manner which will prevent deterioration or damage, contamination with foreign matter, damage by weather or elements, and in accordance with Manufacturer's directions.
- C. Store materials indoors and protect from weather. When necessary to store outdoors, elevate materials above grade and enclose with durable, watertight wrapping.
- D. Reject damaged, deteriorated, or contaminated materials and immediately remove from the Site. Replace rejected materials with new materials at no additional cost to Owner.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. 240/120 V AC Maximum:
  1. Schneider Electric; Square D Products: NQ.
  2. No exceptions.
- B. 480Y/277V AC Maximum:
  1. Schneider Electric; Square D Products: NF.
  2. No exceptions.
- C. 480V AC Maximum:
  1. Schneider Electric; Square D Products: ILINE, QMB.
  2. No exceptions.
- D. All panelboards shall be products of the same Manufacturer.

#### 2.2 MATERIALS

- A. General:
  1. All panelboards shall have plated copper bus bars and full-sized neutral bar.
  2. Bussing shall meet UL Standard 67 for maximum heat rise.
  3. Bussing Type: Distributed phase.
- B. Circuit Breaker Panelboards:
  1. Automatic circuit breaker type with individual breaker unit for each circuit, interchangeable, and removable without disturbing adjacent units.
  2. Complete front trim with door and flush lock, with 2 keys.
  3. Cabinets and fronts shall meet UL Standards for gutter space and material gage.

4. All panelboards shall have common keying.
5. All panelboards shall have a circuit directory frame with plastic cover and card mounted inside cover.
6. Trim for panelboards shall have door-in-door construction with piano hinge. Outer door shall permit full access to the panelboard interior. Inner door shall permit access to breaker operating handles and labeling but current carrying terminals and bus shall remain concealed.
7. Flush mounted double tub panelboards in finished areas shall have a common front cover.
8. Panelboard shall have electrical rating as indicated on the Drawings.
9. Flush mounted panelboards shall have cover flange to overlap cabinet.
10. Finish panelboards in gray enamel over rust inhibitor primer.
11. Branch circuit breakers are to be bolt-on type.
12. Load centers not allowed unless noted otherwise.

C. Fusible Panelboards:

1. Fusible switch type, complete with fusible branch switches with provisions for dual element fuses.
2. Fusible branch switches shall be quick-make, quick-break, visible blade, horsepower rated with cover interlock.
3. Provide a means to allow authorized personnel to release the interlock for inspection purposes.
4. Mount laminated name plates providing circuit identification on each disconnect switch.
5. Switch Types:
  - a. Rated 200 amperes and less: Plug-in type.
  - b. Rated 400 amperes and more: Bolted on type.
6. Each fusible switch shall have an individual door and the switch handle shall be capable of being locked in the off position.
7. Finish panelboard in gray enamel over rust inhibitor primer.

D. Short-Circuit Rating: Provide a single integrated rating of each panelboard certifying capability of withstanding fault stresses equal to the lowest interrupting rating of any overcurrent protective device contained in the panelboard.

## 2.3 IDENTIFICATION

- A. Panelboard Nameplate: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles shall be located at an accessible location on the interior of the panelboard door.
- B. Breaker Labels: Faceplate shall list current rating, UL and IEC certification standards, and AIC rating.
- C. Circuit Directory: Computer-generated, typewritten circuit directory mounted inside panelboard door and placed in metal frame with transparent protective cover.
  1. Circuit directory shall identify specific purpose and location of equipment served with detail sufficient to distinguish it from all other circuits.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine the areas and conditions under which panelboards and enclosures are to be installed and notify Engineer in writing of conditions detrimental to the operation or the proper and timely completion of the work.

### 3.2 INSTALLATION

- A. Anchoring:
  1. Anchor enclosures firmly to walls and structural surfaces, ensuring that they are permanently and mechanically secured.
  2. Locate top of enclosures approximately 6'-0" above floor, at a masonry joint if applicable.
  3. Mount free-standing distribution panelboards on 4-inch high concrete pads with 1-inch chamfered edges.
  4. Where panelboards are flush mounted, stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab, not on grade, into accessible ceiling space below.

- B. Circuit Directories: Upon completion of work, install project specific, computer generated, typewritten circuit directories in all lighting and appliance branch-circuit panelboards.
- C. Panelboard Identification Nameplates: Label each panelboard with a nameplate complying with the requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
- D. Device Nameplates: Label each branch circuit device in power panelboards with nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
- E. Install warning signs complying with requirements in Division 26 Section "Identification for Electrical Systems" identifying source of remote circuit.

### 3.3 FIELD QUALITY CONTROL

- A. Acceptance Testing Preparation:
  - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
  - 2. Test continuity of each circuit.

END OF SECTION 26 24 16

## SECTION 26 27 26 – 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.

#### 1.2 SUMMARY

- A. This Section includes the furnishing and installation of all wiring devices and the major items listed below:
  1. Receptacles.
  2. Switches.
  3. Wall plates.
  4. Box covers.

#### 1.3 REFERENCES

- A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with the following:
  1. NEMA - National Electrical Manufacturer's Association - Standards for general and specific purpose wiring devices WD-1, WD-s.
  2. Federal Specifications WC-596 and WS-896.
  3. Underwriter Laboratories (UL) Standard 498.

#### 1.4 SUBMITTALS

- A. Shop Drawings: For wiring devices.
  1. Name of Manufacturer.
  2. Model number.
  3. Details of construction and installation
  4. Electrical specifications and ratings.
  5. Dimensional data.
  6. Color and finish.

#### 1.5 QUALITY ASSURANCE

- A. Regulatory Agencies Requirements:
  1. NEC - National Electrical Code (NFPA 70) as applicable to construction and installation of electrical wiring devices.
  2. UL Labels. Provide wiring devices which have been tested and are listed and labeled by Underwriters' Laboratories.

#### 1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver all materials in original, unbroken, brand marked containers or wrapping as applicable.
- B. Handle and store materials in a manner which will prevent deterioration or damage, contamination with foreign matter, damage by weather or elements, and in accordance with Manufacturer's directions.
- C. Store materials indoors and protect from weather. When necessary to store outdoors, elevate materials above grade and enclose with durable, watertight wrapping.
- D. Reject damaged, deteriorated, or contaminated materials and immediately remove from the Site. Replace rejected materials with new materials at no additional cost to Owner.

## PART 2 - PRODUCTS

### 2.1 WIRING DEVICES

- A. General:
1. Provide factory-fabricated wiring devices in type, color, and electrical rating as indicated on the symbol legend.
  2. Where type and grade are not indicated, proper selection shall be determined by installer to fulfill the wiring requirements and to comply with NEC and NEMA standards for wiring devices.
- B. Manufacturers: Provide products by the following Manufacturer for switches and receptacles specified:
1. Hubbell Incorporated: – NO SUBSTITUTIONS.
- C. Switches:
1. Switch Rating: 20 amp, 120/127V, specification grade, quiet operating.
  2. Switch Provisions: Back and side wiring.
  3. Device Color: To be selected during submittal.
  4. Manufacturer: Hubbell HBL1220 Series.
- D. Duplex Receptacles:
1. Ratings: 20 amp, 125V, industrial, heavy duty, specification grade.
  2. Provisions: Back and side wiring, grounding screw.
  3. One Piece Mounting Strap: 260 brass, 0.05-inch thick.
  4. Device Color: To be selected during submittal.
  5. Manufacturer: Hubbell HBL5362 Series.
- E. Ground Fault Circuit Interrupter Duplex Receptacles:
1. Ratings: 20 amp, 125V, self-test, extra heavy duty, industrial, tamper-resistant, specification grade.
  2. Provisions: Feed through protection.
  3. Nickel plated brass mounting strap.
  4. Device Color: To be selected during submittal.
  5. Manufacturer: Hubbell GF5362SG Series.
- F. Wall Plates:
1. Number: Provide a single (switch or duplex outlet) wall plate for wiring devices grouped at each location.
  2. Attachment: Provide metal screws for securing plates to devices, screw heads colored to match finish of plate.
  3. Construction:
    - a. Stainless Steel: 0.04-inch thick, Type 302 satin finished stainless steel, accurately die cut, protected with release paper.
    - b. Cast Metal: Die cast profile, ribbed for strength, flash removed, painted with gray enamel, furnished complete with 4 mounting screws with gaskets.
    - c. Steel: Hot dip galvanized, 1.25 ounce per square foot minimum.
  4. Plate Application:
    - a. When surface mounted device boxes are utilized, the plate shall match the box (i.e., a 4 square box shall require a raised device cover, an FS or FD box shall require an FS or FD device cover.
    - b. Flush Mounting Devices: Beveled type with smooth edge:
      - 1) Finished Areas: Stainless steel.
      - 2) Unfinished Areas: Galvanized steel.
    - c. Surface Mounted Devices In Unfinished Process Spaces: Galvanized steel.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. General:
1. Install wiring devices in accordance with:
    - a. The Drawings.
    - b. Manufacturer's written instructions.

- c. Applicable requirements of NEC and National Electrical Contractors Association's "Standard of Installation".
      - d. Recognized industry practices to ensure that products serve intended function.
    2. Delay installation of devices until wiring is completed.
    3. Install receptacles and switches only in electrical boxes which are clean and free from excess building materials and debris.
  - B. Switches:
    1. Install as indicated on the Drawings to control lights as indicated.
    2. Where more than 1 wall switch is installed in same location, set under 1 cover plate.
  - C. Receptacles:
    1. Locate approximately as indicated on the Drawings, long dimension vertical, with grounding pole at top.
    2. Centerline generally at 18 inches above floor on a tile or block joint unless otherwise indicated on the Drawings. When mounting height exceeds 27 inches above floor, mount horizontally with grounding pole at left.
    3. Refer to architectural Drawings for specific location requirements for architectural details when located above counters (long dimension horizontal), and for centering to meet architectural conditions.
    4. Refer to mechanical Drawings for coordination with mechanical equipment, radiation, fin tube, grilles, and diffusers.
    5. Provide bonding jumper from outlet to box.
  - D. Multi-Outlet Assemblies:
    1. Mount 2 inches above countertop backsplash. Where there is no cabinetry, mount 18 inches above finished floor.
    2. In multi-circuited outlet assemblies, configure so that adjacent outlets are not on the same circuit.
  - E. Wall Plates:
    1. Install coverplates on all wiring devices
    2. Plate shall cover entire wall opening.
- 3.2 FIELD QUALITY CONTROL
- A. Testing: Test wiring devices to ensure electrical continuity of grounding connections, and test after energizing circuitry, to demonstrate compliance with requirements.
- 3.3 PROTECTION OF WALL PLATES AND RECEPTACLES
- A. Upon installation of wall plates and receptacles, advise Subcontractors regarding proper and cautious use of convenience outlets. At time of Substantial Completion, replace those items which have been damaged, including those burned and scored by faulty plugs.

END OF SECTION 26 27 26

## SECTION 26 28 00 – LOW VOLTAGE CIRCUIT PROTECTIVE 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.

#### 1.2 SUMMARY

- A. This Section includes the furnishing and installation of all low voltage circuit protective devices:
  - 1. The types of low voltage circuit protective devices required for the Project and specified in this Section include the following:
    - a. Fuses.
    - b. Circuit breakers.

#### 1.3 REFERENCES

- A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with the following:
  - 1. UL 489 – Molded Case Circuit Breakers.
  - 2. NEMA AB1 – Molded Case Circuit Breakers.
  - 3. NEMA 250 – Enclosures for Electrical Equipment.
  - 4. NFPA 70 – National Electrical Code.

#### 1.4 SUBMITTALS

- A. Manufacturer's literature for each type of low voltage circuit protective device furnished to include:
  - 1. Name of Manufacturer.
  - 2. Model.
  - 3. Time-current curves.
  - 4. Interrupt ratings.
  - 5. NEC class.
  - 6. Details of construction and installation.
  - 7. Options and accessories.
- B. Installation Instructions: For low voltage circuit protective devices.
- C. Operation and Maintenance Manuals: For low voltage circuit protective devices.
  - 1. Equipment function, normal operating characteristics, and limiting conditions.
  - 2. Assembly, installation, alignment, adjustment, and checking instructions.
  - 3. Operating instructions for start-up, routine and normal operating, regulation and control, shutdown, and emergency conditions.
  - 4. Maintenance instructions.
  - 5. Guide to "troubleshooting."
  - 6. Parts list and predicted life of parts subject to wear.
  - 7. Project specific outline and cross sections, assembly drawings, engineering data, and wiring diagrams.
  - 8. Test data and performance curves.

#### 1.5 QUALITY ASSURANCE

- A. Fabrication and Installation Personnel Qualifications:
  - 1. Trained and experienced in the fabrication and installation of the materials and equipment.
  - 2. Knowledgeable of the design and the reviewed submittals.
- B. Provide fuses and circuit breakers which have been tested, listed, and labeled by Underwriters' Laboratory.



1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver all materials in original, unbroken, brand marked containers or wrapping as applicable.
- B. Handle and store materials in a manner which will prevent deterioration or damage, contamination with foreign matter, damage by weather or elements, and in accordance with Manufacturer's directions.
- C. Store materials indoors and protect from weather. When necessary to store outdoors, elevate materials above grade and enclose with durable, watertight wrapping.
- D. Reject damaged, deteriorated, or contaminated materials and immediately remove from the Site. Replace rejected materials with new materials at no additional cost to Owner.

PART 2 - PRODUCTS

2.1 FUSES

- A. General: Provide fuses manufactured by Bussmann, Inc. as required for all motor starters, fused disconnect switches, and other equipment requiring fuse protection as indicated on the Drawings, or in absence thereof, as selected by the installer to meet the specific electrical requirements of the equipment being served. Select only from the following:
  - 1. Dual element plug fuses, 0-30 ampere, 150 volt, 10,000 ampere interrupting rating: Buss "Fusetron".
  - 2. Dual element fuse, 0-600 ampere, 250 or 600 volt, 200,000 ampere interrupting rating, Type R-K5: Buss "Fusetron".
  - 3. 601 amperes and above, 250 or 600 volt, 200,000 ampere interrupting rating: Buss "Hi-Cap".
- B. All fuses shall be by one Manufacturer.

2.2 CIRCUIT BREAKERS

- A. General:
  - 1. Provide required circuit breakers for installation in panelboards, switchboards, individual enclosures, or motor control centers. Circuit breaker Manufacturer shall be that of the equipment in which it is installed or shall be supplied by that equipment Manufacturer.
  - 2. Provide electronic trip circuit breakers where indicated on the Drawings.
  - 3. All breakers shall be rated for the applied voltage and have a minimum 10,000-amp interrupt rating.
- B. Mechanism: Molded case circuit breakers shall have over center toggle-type mechanisms, providing quick-make, quick-break action. Breakers shall be calibrated for operation in an ambient temperature of 40 degrees C. Each circuit breaker shall have trip indication by handle position and shall be trip-free. 2 and 3 pole breakers shall be common trip.
- C. Thermal Magnetic Trip:
  - 1. Each circuit breaker shall have a permanent trip unit containing individual thermal and magnetic trip elements in each pole.
  - 2. Circuit breakers with frame sizes greater than 100 amperes shall have variable magnetic trip elements which are set by a single adjustment (to ensure uniform tripping characteristics in each pole).
  - 3. Single pole 15 and 20 ampere breakers shall be SWD rated.
- D. Enclosures:
  - 1. Provide a UL listed circuit breaker enclosure for each individually mounted circuit breaker.
  - 2. Enclosure to have NEMA rating for its intended location NEMA 12.
  - 3. Provide handle mechanism padlockable in "OFF" position.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install fuses in all combination motor starters, fused disconnects, and equipment as required. Install circuit breakers in all panelboards, switchboards, and motor control centers as required.

3.2 FIELD SETTINGS

- A. Perform field adjustments of protective devices as required to place the equipment in final operating condition. Settings shall be in accordance with the recommendations of the reviewed coordination study.

END OF SECTION 26 28 00

## SECTION 26 28 20 – ENCLOSED 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.

#### 1.2 SUMMARY

- A. This Section includes the furnishing and installation of all switching devices or means of disconnecting motors and other electrically powered equipment.

#### 1.3 REFERENCES

- A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with the following:
  - 1. NEMA - National Electrical Manufacturers Association: Standard KS1 for enclosed switches.

#### 1.4 SUBMITTALS

- A. Shop Drawings: For disconnect switches.
  - 1. Name of Manufacturer.
  - 2. Model number.
  - 3. Details of construction and installation.
  - 4. Assembly drawings, including elevations, plans, sections, dimensions, weight, and conduit entry locations.
  - 5. Electrical Ratings:
    - a. Voltage.
    - b. Amperage.
    - c. Interrupt rating.
    - d. Enclosure type.
  - 6. Color and finish.
  - 7. Options and accessories.
- B. Installation Instructions: For disconnect switches.
- C. Operation and Maintenance Manuals: For disconnect switches.
  - 1. Equipment function, normal operating characteristics, and limiting conditions.
  - 2. Assembly, installation, alignment, adjustment, and checking instructions.
  - 3. Operating instructions for start-up, routine and normal operating, regulation and control, shutdown, and emergency conditions.
  - 4. Maintenance instructions.
  - 5. Guide to "troubleshooting."
  - 6. Parts list and predicted life of parts subject to wear.
  - 7. Project specific outline and cross sections, assembly drawings, engineering data, and wiring diagrams.
  - 8. Test data and performance curves.

#### 1.5 QUALITY ASSURANCE

- A. Fabrication and Installation Personnel Qualifications:
  - 1. Trained and experienced in the fabrication and installation of the materials and equipment.
  - 2. Knowledgeable of the design and the reviewed submittals.

- B. Regulatory Agencies Requirements:
  - 1. Comply with National Electrical Code (NFPA 70) as applicable to construction and installation of electrical disconnect switches.
  - 2. Provide disconnect switches which have been listed and labeled by Underwriters' Laboratories.
  - 3. Comply with OSHA lockout/tagout requirements.

#### 1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver all materials in original, unbroken, brand marked containers, or wrapping as applicable.
- B. Handle and store materials in a manner which will prevent deterioration or damage, contamination with foreign matter, damage by weather or elements, and in accordance with Manufacturer's directions.
- C. Store materials indoors and protect from weather. When necessary to store outdoors, elevate materials above grade and enclose with durable, watertight wrapping.
- D. Reject damaged, deteriorated, or contaminated materials and immediately remove from the Site. Replace rejected materials with new materials at no additional cost to Owner.

### PART 2 - PRODUCTS

#### 2.1 FABRICATED SWITCHES

- A. Manufacturers: Provide products produced by one of the following Manufacturers (for each type of switch):
  - 1. Schneider Electric; Square D Products – NO SUBSTITUTIONS.
- B. General:
  - 1. Provide heavy duty disconnect switches for all motors and equipment as indicated on the Drawings.
  - 2. Provide disconnect switches for all motors not in sight of supplying distribution panel whether indicated on the Drawings or not, as required by NEC.
- C. Switch Enclosures: Provide disconnect switches with NEMA enclosures 1, 3R, 4X, 7, or 12 as indicated on the Drawings, or in absence thereof, as determined by installer to fulfill the requirements of the environment.
- D. Heavy Duty Safety Switches:
  - 1. Provide heavy duty type, sheet steel enclosed safety switches, of the type and size and electrical characteristics indicated, surface mounted, fusible or nonfusible, rated at 250 or 600 volts, 60 hertz, 3 blades, incorporating quick-make, quick-break type switches, constructed so switch blades are visible in "off" position with door open; equipped with operating handle which is an integral part of the enclosure base and whose position is easily recognizable and is padlockable in the "off" position; with current carrying parts constructed of high-conductivity copper, and silver-tungsten type switch contact; with positive pressure type reinforced fuse clips.
  - 2. Fuse clips shall accept only Class R type fuses.
  - 3. All disconnect switches shall be horsepower rated.
- E. Switch Interlock:
  - 1. Provide switches with dual cover interlock to prevent opening door with switch in "on" position or closing switch with door open.
  - 2. Interlocks shall be defeatable with the use of a screwdriver to intentionally gain access to an energized switch in the "on" position.

### PART 3 - EXECUTION

#### 3.1 INSPECTION

- A. General:
  - 1. Examine the areas and conditions under which disconnect switches are to be installed and notify Engineer in writing of conditions detrimental to the proper and timely completion of the work.
  - 2. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to Engineer.

### 3.2 INSTALLATION

- A. General:
  - 1. Install disconnect switches where indicated, in accordance with Manufacturer's written instructions, the applicable requirements of NEC and the National Electrical Contractors Association's "Standard of Installation", and in accordance with recognized industry practices to ensure that products serve the intended function.
  - 2. Provide fused disconnect switches serving rooftop units and all other heating, air conditioning, and refrigeration equipment comprising of multi-motor or combination loads.
- B. Coordination: Coordinate disconnect switch installation work with electrical raceway and cable work, as necessary for proper interface.
- C. Location:
  - 1. Install disconnect switches used with motorized equipment within sight of the controller position unless otherwise indicated.
  - 2. Mount on wall whenever possible, otherwise provide supporting device adjacent to equipment being served.
- D. Fuses: Provide fuses for disconnect switches in accordance with Division 26 Section "Low Voltage Circuit Protective Devices."

END OF SECTION 26 28 20

## SECTION 26 29 13 – ENCLOSED CONTROLLERS

### 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 furnishing and installation of all enclosed controllers.
- B. The types of enclosed controllers required for the Project include the following:
  - 1. Manual motor starters.
  - 2. Magnetic motor starters.
  - 3. Combination magnetic motor starter/fusible disconnect switches.
  - 4. Combination magnetic motor starter/motor circuit protector disconnect switches.

#### 1.3 REFERENCES

- A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with the following:
  - 1. NEMA Standards:
    - a. AB 1 – Molded-Case Circuit Breakers, Molded Case Switches, and Circuit-Breaker Enclosures.
    - b. AB 3 – Molded Case Circuit Breakers and Their Application.
    - c. ICS 2 – Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated 600 Volts.
  - 2. ANSI/NETA Standards:
    - a. ATS – Acceptance Testing Specifications for Electrical Power Equipment and Systems.
  - 3. NFPA Standards:
    - a. 70 – National Electrical Code.
    - b. 70E – Standard for Electrical Safety in the Workplace.
  - 4. Underwriters Laboratory (UL) Standards:
    - a. 489 – Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.
    - b. 508 – Standard for Industrial Control Equipment.
    - c. 508C – Power Conversion Equipment.

#### 1.4 SUBMITTALS

- A. Product Data: For each type of enclosed controller. Include shipping and operating weights, features, performance, electrical ratings, operating characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For each enclosed controller, manufacturer's approval drawings as defined in UL 845. In addition to requirements specified in UL 845, include dimensioned plans, elevations, and sections; and conduit entry locations and sizes, mounting arrangements, and details, including required clearances and service space around equipment.
  - 1. Name of Manufacturer.
  - 2. Model number.
  - 3. Details of construction and installation.
  - 4. Vertical and horizontal bus ratings.
  - 5. Color and finish.
  - 6. Options and accessories.
  - 7. Show tabulations of installed devices, equipment features, and ratings. Include the following:
    - a. Each installed unit's type and details.
    - b. Factory-installed devices.
    - c. Enclosure types and details.
    - d. Nameplate legends.

- e. Short-circuit current (withstand) rating.
- f. Features, characteristics, ratings, and factory settings of each installed device.
- g. Specified optional features and accessories.
- 8. Project Specific Schematic and Connection Wiring Diagrams:
  - a. Identify power, signal, and control wiring for each controller.
  - b. Clearly identify all field wiring requirements.
  - c. Typical diagrams are acceptable for multiple motors or loads controlled in the same manner.
- C. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor running overload protection suit actual motors to be protected.
- D. Installation Instructions: For enclosed controllers. Include a copy of the Manufacturer's Field Service Division's commissioning, acceptance testing, and start up procedures.
- E. Operation and Maintenance Manuals: For enclosed controllers.
  - 1. Equipment function, normal operating characteristics, and limiting conditions.
  - 2. Assembly, installation, alignment, adjustment, and checking instructions.
  - 3. Operating instructions for start-up, routine and normal operating, regulation and control, shutdown, and emergency conditions.
  - 4. Maintenance instructions.
  - 5. Guide to "troubleshooting".
  - 6. Parts lists and predicted life of parts subject to wear.
  - 7. Project specific outline and cross sections, assembly drawings, engineering data, and wiring diagrams. Wiring diagrams shall reflect final, as-installed conditions and include wire numbers.
  - 8. Manufacturer's Record Drawings: As defined in UL 845. In addition to requirements specified in UL 845, include field modifications and field-assigned wiring identification incorporated during construction by manufacturer, Contractor, or both.
  - 9. Test data and performance curves.

#### 1.5 QUALITY ASSURANCE

- A. Fabrication and Installation Personnel Qualifications:
  - 1. Trained and experienced in the fabrication and installation of the materials and equipment.
  - 2. Knowledgeable of the design and the reviewed submittals.
- B. All equipment shall be tested in accordance with NEMA ICS-2, bear the UL Label, and be listed for the application specified.

#### 1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver all materials in original, unbroken, brand marked containers or wrapping as applicable.
- B. Handle and store materials in a manner which will prevent deterioration or damage, contamination with foreign matter, damage by weather or elements, and in accordance with Manufacturer's directions.
- C. Store materials indoors and protect from weather. When necessary to store outdoors, elevate materials above grade and enclose with durable, watertight wrapping.
- D. Reject damaged, deteriorated, or contaminated materials and immediately remove from the Site. Replace rejected materials with new materials at no additional cost to Owner.

#### 1.7 COORDINATION

- A. Coordinate features of enclosed controllers and accessory devices with pilot devices and control circuits to which they connect.
- B. Coordinate features, accessories, and functions of each enclosed controller with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor or load.

## 1.8 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. Power Fuses: Equal to 10% of quantity installed for each size and type, but no fewer than 3 of each size and type. Provide 1 fuse puller.
  - 2. Control Circuit Fuses: Equal to 10% of quantity installed for each size and type, but no fewer than 2 of each size and type. Provide 1 fuse puller.
  - 3. Indicating Lights: 2 lamps and lenses of each type and color installed.
  - 4. Auxiliary Contacts: 1 spare for each size and type of magnetic controller installed.
  - 5. Power Contacts: 3 spares for each size and type of magnetic controller installed.
  - 6. Coils: 1 for each size and type of magnetic controller installed.
  - 7. Overload Relays: One for each size installed.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Provide products manufactured by the following:
  - 1. Schneider Electric; Square D Products.
  - 2. No exceptions.
- B. All enclosed controllers to be of the same Manufacturer.

### 2.2 MATERIALS AND EQUIPMENT

- A. Manual Motor Starters for Fractional HP Motors:
  - 1. Operating mechanism shall be of the quick-make, quick-break toggle switch type and shall be mechanically trip-free requiring a reset operation before the starter can be reset. Contacts shall be silver alloy. Noncurrent carrying parts shall be mounted on molded porcelain, bakelite, or composition base.
  - 2. Overload protection shall be provided with 1 thermal overload heater block for each pole. All overload relays shall be of the melting alloy type.
  - 3. All FHP manual starters shall be equipped with thermal overload relay and handle guard/lock-off mechanism.
  - 4. Manual starters shall include an on-off indicating light. Light to be unless indicated otherwise.
- B. Enclosed Controllers:
  - 1. Motor Starters: Combination type (disconnect and controller) rated in accordance with NEMA size designations. Fractional sizes and ratings in accordance with IEC recommendations are not acceptable. Comply with NEMA ICS 2, general purpose, Class A.
  - 2. Fusible Switch Disconnect: NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate Class J fuses. Ampere rating to be selected per horsepower indicated on the Drawings. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position and includes a defeatable interlock to prevent opening unless the disconnect is OFF. Auxiliary Contacts: NO/NC, arranged to activate before switch blades open.
  - 3. Controllers:
    - a. Full-voltage, non-reversing, NEMA Size 1 (minimum), electrically held, field replaceable coil and contacts, auxiliary contacts field installable and removable. Terminal temperature rise is not to exceed 50 degrees C in accordance with NEMA standards.
      - 1) Configuration: Standard duty; non-reversing.
      - 2) Shorting (Bypass) Contactor: Operates automatically when full voltage is applied to motor, and bypasses the SCRs. Solid-state controller protective features shall remain active when the shorting contactor is in the bypass mode.
      - 3) Shorting Contactor Coils: Pressure-encapsulated type; manufacturer's standard operating voltage, matching control power or line voltage, depending on contactor size and line-voltage rating. Provide coil transient suppressors.
      - 4) Logic Board: Identical for all ampere ratings and voltage classes, with environmental protective coating.
      - 5) SCR bridge shall consist of at least 2 SCRs per phase, providing stable and smooth acceleration without external feedback from the motor or driven equipment.



- 6) Keypad, front accessible; for programming the controller parameters, functions, and features; shall be manufacturer's standard and include not less than the following functions:
    - a) Adjusting motor full-load amperes, as a percentage of the controller's rating.
    - b) Adjusting current limitation on starting, as a percentage of the motor full-load current rating.
    - c) Adjusting linear acceleration and deceleration ramps, in seconds.
    - d) Initial torque, as a percentage of the nominal motor torque.
    - e) Adjusting torque limit, as a percentage of the nominal motor torque.
    - f) Adjusting maximum start time, in seconds.
    - g) Adjusting voltage boost, as a percentage of the nominal supply voltage.
    - h) Selecting stopping mode, and adjusting parameters.
    - i) Selecting motor thermal-overload protection Class between 5 and 30.
    - j) Activating and de-activating protection modes.
    - k) Selecting or activating communications modes.
  - 7) Digital display, front accessible; for showing motor, controller, and fault status; shall be manufacturer's standard and include not less than the following:
    - a) Controller Condition: Ready, starting, running, stopping.
    - b) Motor Condition: Amperes, voltage, power factor, power, and thermal state.
    - c) Fault Conditions: Controller thermal fault, motor overload alarm and trip, motor underload, overcurrent, shorted SCRs, line or phase loss, phase reversal, and line frequency over or under normal.
  - 8) Controller Diagnostics and Protection:
    - a) Microprocessor-based thermal protection system for monitoring SCR and motor thermal characteristics, and providing controller over-temperature and motor overload alarm and trip; settings selectable via the keypad.
    - b) Protection from line-side reverse phasing; line-side and motor-side phase loss; motor jam, stall, and underload conditions; and line frequency over or under normal.
    - c) Input isolation contactor that opens when the controller diagnostics detect a faulted solid-state component, or when the motor is stopped.
    - d) Shunt trip that opens the disconnecting means when the controller diagnostics detect a faulted solid-state component.
  - 9) Remote Output Features:
    - a) All outputs prewired to terminal blocks.
    - b) Form C status contacts that change state when controller is running.
    - c) Form C alarm contacts that change state when a fault condition occurs.
  - 10) Optional Features:
    - a) Analog output for field-selectable assignment of motor operating characteristics; 4 to 20-mADC.
    - b) Additional field-assignable Form C contacts for alarm outputs.
    - c) Surge suppressors in solid-state power circuits providing three-phase protection against damage from supply voltage surges 10% or more above nominal line voltage.
    - d) Full-voltage bypass contactor operating based on NORMAL/BYPASS selector switch. Power contacts shall be totally enclosed, double break, and silver-cadmium oxide; and assembled to allow inspection and replacement without disturbing line or load wiring.
4. Overload Relays:
    - a. Melting alloy type:
      - 1) Inverse-time-current characteristic.
      - 2) Class 20 tripping characteristic.
      - 3) Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle. Capable of handling the horsepower range of the starter by changing the thermal elements only.
      - 4) Provide cover mounted "reset" pushbutton.
    - b. Bimetallic Type:
      - 1) Inverse-time-current characteristic.
      - 2) Class 20 tripping characteristic.
  5. Control Power: 120 VAC; obtained from integral CPT, with primary and secondary fuses; with CPT of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices. Spare capacity: 50 VA.
  6. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller.

- C. Enclosures:
  - 1. Provide enclosed controllers with NEMA enclosures 1, 3R, 4X, 7 or 12 as indicated on the Drawings or schedules, or in absence thereof, as determined by installer to fulfill the requirements of the environment.
  - 2. Constructed to fully compartmentalize the starter and arranged to permit access to starter, control power transformer, fuses, and other components without requiring disassembly.
  
- D. Auxiliary Devices:
  - 1. General Requirements for Control Circuit and Pilot Devices: NEMA ICS 5; UL listed; factory installed in controller enclosure cover unless otherwise indicated.
    - a. Push Buttons, Indicating Lights, and Selector Switches: Full size, heavy-duty, oil-tight type, industrial grade.
      - 1) Push Buttons: Maintained or momentary contacts as indicated.
      - 2) Indicating Lights: LED type; color as indicated; with push to test feature where indicated.
      - 3) Selector Switches: Maintained contacts with number of positions as indicated.
    - b. Elapsed-Time Meters: Six digit, non-resettable, heavy-duty with readout in hours and tenths.
  - 2. Control Relays: Heavy duty, 600 volt, machine tool type, 10 amp (minimum) contact rating. Auxiliary and adjustable solid-state time-delay relays. Provide retaining clips with plug-in type relays.
  - 3. Phase-Failure, Phase-Reversal, Undervoltage, Overvoltage, and Phase-Imbalance Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage and time-delay on undervoltage settings.
  - 4. Refer to wiring diagrams for specific requirements.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine the areas and conditions under which enclosed controllers are to be installed and notify Engineer in writing of conditions detrimental to the operation or the proper and timely completion of the Work.

### 3.2 INSTALLATION

- A. General:
  - 1. Install enclosed controllers at locations indicated on the Drawings.
  - 2. In accordance with Manufacturer's instructions.
  - 3. Comply with NECA 1.
  - 4. Overload elements and settings shall be selected based on motor nameplate ratings.
  - 5. Bundle, train, and support wiring in enclosures.
  
- B. Wall-Mounted Enclosed Controllers: Install enclosed controllers on walls with tops at uniform height, and with disconnect operating handles not higher than 72 inches above finished floor, unless otherwise indicated, and by mounting on channels bolted to wall. For enclosed controllers not at walls, provide free-standing racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."
  
- C. Identification: Label each enclosed controller with a nameplate complying with the requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

### 3.3 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:
  - 1. Verify that voltages at controller locations are within 10% of motor nameplate rated voltages.
  - 2. Test each motor for proper phase rotation.
  - 3. Test insulation resistance for each enclosed controller, component, connecting supply, feeder, and control circuit.
  - 4. Test continuity of each circuit.

- B. For all enclosed controllers and auxiliary devices, perform each electrical test and visual and mechanical inspection as outlined in the latest edition of ANSI/NETA ATS – Acceptance Testing Specifications. Certify compliance with test parameters. Submit written reports documenting each electrical test.
  - 1. ANSI/NETA Testing shall be performed by a NETA-certified testing company.

END OF SECTION 26 29 13

## SECTION 26 50 00 – 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.

#### 1.2 SUMMARY

- A. This Section includes the furnishing and installation of all lighting and the major items listed below:
  - 1. Interior luminaires.
  - 2. Exterior luminaires.
  - 3. Drivers.
  - 4. LEDs/Lamps installed in luminaires.
  - 5. Emergency lighting units.
  - 6. Exit signs.
  - 7. Luminaire supporting systems.

#### 1.3 REFERENCES

- A. Except as herein specified or as indicated on the Drawings, the work of this Section shall comply with the following:
  - 1. ANSI-UL Standards:
    - a. 924 - Emergency Lighting and Power Equipment.
    - b. 1449, Surge Protective Devices.
    - c. 1598 – Luminaires.
    - d. 8750 – Light Emitting Diode (LED) Equipment for Use in Lighting Products.
  - 2. NFPA:
    - a. 70 – National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
    - b. 101 – Life Safety Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction.
  - 3. FCC Rules.
  - 4. Illuminating Engineering Society of North America (IES):
    - a. LM-79 – Electrical and Photometric Measurements of Solid-State Lighting Products.
    - b. LM-80 – Measuring Lumen Maintenance of LED Light Sources.
    - c. TM-15 – Luminaire Classification System for Outdoor Luminaires.
    - d. TM-21 – Projecting Long Term Lumen Maintenance of LED Light Sources.
  - 5. LED Lighting Facts:
    - a. Submission Requirements:
      - 1) (<http://www.lightingfacts.com/About/Content/Manufacturers/SubmissionRequirements>).
  - 6. Energy Star:
    - a. Energy Star TM-21 Calculator, rev. 08.28.14 or latest ([www.energystar.gov/TM-21Calculator](http://www.energystar.gov/TM-21Calculator)).

#### 1.4 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color Rendering Index.
- C. Fixture: See “Luminaire.”
- D. IP: International Protection or Ingress Protection Rating
- E. LED: Light-emitting diode.
- F. Lumen: Measured output of lamp and luminaire, or both.

- G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.
- H. Useful Life (For LED Luminaire Light Source) - The operating hours before reaching 70% of the initial rated lumen output (L70) with no catastrophic failures under normal operating conditions. This is also known as 70% "Rated Lumen Maintenance Life" as defined in IES TM-80.

#### 1.5 SUBMITTALS

##### A. Shop Drawings:

1. For luminaires, submit the following:
  - a. Luminaire designation.
  - b. Name of Manufacturer.
  - c. Model number.
  - d. Details of construction and installation.
  - e. Dimensions and rough-in requirements.
  - f. Voltage.
  - g. Photometric data and adjustment factors based on laboratory tests.
  - h. Ballast / Driver Data:
    - 1) Name of Manufacturer.
    - 2) Model number.
    - 3) Operating characteristics.
  - i. Wiring diagrams.
  - j. Color and finish.
  - k. Options and accessories.
2. For Interior LED Luminaires, submit the following:
  - a. Life, output (lumens, CCT, and CRI), and energy efficiency data.
  - b. LED Luminaire – IES LM-79 Test Report.
  - c. LED Luminaire – IES LM-80 Test Report.
  - d. Provide long term lumen maintenance projections for each LED luminaire in accordance with IES TM-21. Data used for projections shall be obtained from testing in accordance with IES LM-80. According to IES TM-21, "Reported" values are restricted to 5.5x or 6x (depending on sample size) the duration of IES LM-80 testing, whereas "Calculated" (i.e., projected) values are unrestricted. Manufacturer shall indicate whether TM-21 data is "Reported" or "Calculated".

##### B. Operation and Maintenance Manuals: For Luminaires.

1. Equipment function, normal operating characteristics, and limiting conditions.
2. Assembly, installation, alignment, adjustment, and checking instructions.
3. Operating instructions for start-up, routine and normal operating, regulation and control, shutdown, and emergency conditions.
4. Maintenance instructions.
5. Guide to "troubleshooting."
6. Parts list and predicted life of parts subject to wear.
7. Project specific outline and cross sections, assembly drawings, engineering data, and wiring diagrams.
8. Test and performance curves.

##### C. Record Drawings: Submit 2 copies to Owner identifying maintenance and lamp replacement requirements.

#### 1.6 QUALITY ASSURANCE

##### A. Fabrication and Installation Personnel Qualifications:

1. Trained and experienced in the fabrication and installation of the materials and equipment.
2. Knowledgeable of the design and the reviewed submittals.

##### B. All equipment shall be UL listed.

## 1.7 WARRANTY

- A. In accordance with the warranty provisions defined in the General Conditions and Supplementary Conditions:
  - 1. LED Luminaires:
    - a. Provide 5 year manufacturer warranty for all LED luminaires, including drivers, luminaire housing, wiring, and connections.
    - b. Loss of 10% or more of light output from the LED sources in an LED luminaire during the warranty period constitutes luminaire failure.
  - 2. All Other Non-LED Luminaires:
    - a. Includes all ballasts.
    - b. Does not include lamps.

## 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver all materials in original, unbroken, brand marked containers or wrapping as applicable.
- B. Handle and store materials in a manner which will prevent deterioration or damage, contamination with foreign matter, damage by weather or elements, and in accordance with Manufacturer's directions.
- C. Store materials indoors and protect from weather. When necessary to store outdoors, elevate materials above grade and enclose with durable, watertight wrapping.
- D. Reject damaged, deteriorated, or contaminated material and immediately remove from the Site. Replace rejected materials with new materials at no additional cost to Owner.

## PART 2 - PRODUCTS

### 2.1 LUMINAIRE TYPES

- A. Furnish products as indicated in Luminaire Schedule on the Drawings.
- B. Substitutions: In accordance with Division 01 Section "Product Substitution Procedures."

### 2.2 MATERIALS

- A. General:
  - 1. Furnish luminaires with all trims and accessories required for the various types of ceiling and wall construction.
  - 2. All ballasts used in fluorescent luminaires shall be Class "P" rated, high power factor, CBM certified and UL listed.
  - 3. All ballasts shall have an "A" sound rating, where available.
  - 4. Provide "damp" or "wet" location labels on all luminaires installed outdoors and in damp or wet interior locations.
  - 5. All recessed luminaires shall be thermally protected.
  - 6. Provide low temperature ballasts for all luminaires installed outdoors or in unheated interior spaces.
  - 7. All troffers shall be painted after fabrication.
  - 8. Exterior LED luminaires shall be rated for operation within an ambient temperature range of -40-degrees C to 40-degrees C.
  - 9. Interior LED luminaires shall be rated for operation at an average ambient temperature of 25 degrees C.
- B. Lamps: As indicated on Drawings and as listed in the Luminaire Schedule.
- C. Emergency Lighting Units: Provide emergency lighting units as indicated in the Luminaire Schedule.
- D. Exit Signs:
  - 1. Description: Internally illuminated exit signs with LEDs, unless otherwise indicated; complying with NFPA 101 and all applicable state and local codes, and listed and labeled as complying with UL 924.
  - 2. Provide exit signs as indicated on the Luminaire Schedule.
  - 3. Exit signs shall have minimum of 6-inch high letters.

4. Number of faces: Single or double as indicated or as required for the installed location.
5. Directional Arrows: As indicated or as required for the installed location.

E. LED Luminaires:

1. Correlated Color Temperature (CCT) shall be in accordance with NEMA ANSI ANSLG C78.377 – Specifications for the Chromaticity of Solid State Lighting Products.
2. LED Power Supply Units (Drivers): Minimum efficiency shall be 85%.
3. Exterior LED Luminaires shall meet the performance requirements specified in ANSI C136.2 for electrical immunity, using the enhanced combination wave form test level (10kV/5kA).
4. Provide 0 to 10V dimming driver as indicated on the Luminaire Schedule. Dimming range shall be as noted on the Luminaire Schedule.
  - a. Shall be rated to operate between ambient temperatures of -22 degrees F and 104 degrees F.
  - b. Shall be designed to operate on the voltage system to which they are connected.
  - c. Operating frequency shall be 60 Hz.
  - d. Power factor (PF) shall be greater than or equal to 0.90.
  - e. Shall be RoHS-compliant.
  - f. Shall be mounted integral to luminaire. Unless indicated otherwise, remote mounting of power supply is not allowed.
5. LED Luminaire Surge Protection: Provide surge protection integral to luminaire to meet C Low waveforms as defined by IEEE C62.41.2, Scenario 1, Location Category C.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that outlet boxes are installed in proper locations at proper mounting heights and are properly sized to accommodate conductors in accordance with NFPA 70.
- B. Verify that suitable support frames are installed where required.
- C. Verify that branch circuit wiring installation is completed, tested, and ready for connection to luminaires.
- D. Verify that conditions are satisfactory for installation prior to starting Work.

3.2 PREPARATION

- A. Examine all pertinent details (architectural and otherwise) in the Contract Documents that are relevant to the installation of luminaires.
- B. Provide extension rings to bring outlet boxes flush with finished surfaces.
- C. Remove all dirt, debris, plaster, and other foreign materials from outlet boxes.

3.3 INSTALLATION

A. General:

1. Install surface mounted, recessed, or semi-recessed luminaires to maintain the alignment, spacing, layout, and general arrangement indicated on the Drawings.
2. Obtain approval of Engineer for all proposed changes that may be required due to field conditions and/or to avoid conflicts with Work by other trades.
3. Install all luminaires in accordance with Manufacturer's recommendations.
4. Equip all luminaires with the specified quantity of functional lamps prior to Substantial Completion.
5. Unless noted otherwise, all wiring for LED luminaires that are required to be dimmed shall include two #18 AWG control wires from each luminaire driver to the associated lighting controller for 0-10V lighting control. All control wires shall be labeled. Coordinate exact requirements with lighting control Shop Drawings.

6. Install all wiring for emergency lighting and exit signs that are not local battery powered in a raceway system independent from other building wiring.
7. In the installation of exterior luminaires, take care to maintain symmetry with existing installation, while conforming to the Drawings.

B. Coordination:

1. Coordinate locations of recessed and surface mounted luminaires in ceiling systems with Division 09.
2. Locate luminaires according to the reflected ceiling Drawings, if furnished.
3. Coordinate location of luminaires in Mechanical HVAC and Plumbing areas with other trades.
4. Notify Engineer of field conditions that contradict Drawings or Specifications prior to beginning work.
5. Coordinate space conditions that contradict or conflict with Work by other trades before installing luminaires.

C. Mounting and Support:

1. Recessed Luminaires:

- a. Wire luminaires that are mounted in or on the underside of lay-in ceilings with flexible conduit to an outlet box on the rigid conduit system above, such that the rigid conduit system does not interfere with the removal of lay-in ceiling panels or luminaires.
- b. Do not support luminaires directly on ceiling panels.
- c. Install a minimum of four ceiling support system rods or wires for each luminaire. Locate rods or wires not more than 6-inches from the corners of each luminaire
- d. Support Clips: Fasten to each luminaire and to ceiling grid members at or near each luminaire corner with clips that are UL listed for the application.
- e. Securely mount luminaires and electrical boxes to elements of the building structure such that luminaires will be square, plumb, and rigid; and will not fall or sag, and will not cause the suspended ceiling system to fall or sag.
- f. Install at least one independent support rod or wire from structure to a tab on each luminaire. Wire or rod shall have a breaking strength equal to the weight of luminaire plus a safety factor of 3.
- g. Provide all additional means (metal plates, etc.) necessary to support luminaires that would put excessive stress on the ceiling system.

2. Surface Mounted Luminaires:

- a. Securely mount luminaires and electrical boxes to elements of the building structure such that luminaires will be square, plumb, and rigid; and will not fall or sag, and will not cause the ceiling system to fall or sag.
- b. Provide all additional means (metal plates, plywood backing, expansion bolts, toggle bolts, etc.) necessary to support luminaires that would put excessive stress on the ceiling system.

3.4 FIELD QUALITY CONTROL

- A. Test all luminaires and lighting controls for proper operation.
- B. All luminaires shall operate properly.
- C. Adjusting and Aiming:
  1. All final adjusting and aiming of luminaires (such as focusing all adjustable luminaires) shall be done during the night hours. Contractor shall prearrange time with Engineer so Engineer can be present. Final adjustments shall be made as directed in field by Engineer.
  2. Replace all defective luminaires immediately prior to Substantial Completion.

3.5 CLEANING

- A. Clean all luminaire trims, exposed housings, doors, lenses, and reflectors immediately prior to Substantial Completion.

END OF SECTION 26 50 00



## SECTION 28 31 00 – FIRE DETECTION AND ALARM

### 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 furnishing and installation of a complete and functional building fire detection and alarm system.
- B. Division of Work:
  - 1. In accordance with the General Conditions, Contractor is responsible for dividing the Work among the Subcontractors and Suppliers and for delineating the work to be performed by specific trades. The following are suggestions as to how the Work may be divided. This is not a complete list of all the work:
    - a. Electrical Subcontractor:
      - 1) Coordinate equipment.
      - 2) Install and wire all system components.
      - 3) Wire and install all duct smoke detectors. Coordinate location and control requirements with Temperature Control Subcontractor.
      - 4) Wire tamper and flow switches provided by fire protection (sprinkler) system Subcontractor.
    - b. Fire Alarm System Supplier: Test completed system.

#### 1.3 REFERENCES

- A. Except as herein specified or as indicated on the Drawings, the work of the Section shall comply with the following:
  - 1. NFPA Codes/Standards:
    - a. NFPA 70 – National Electrical Code.
    - b. NFPA 72 – National Fire Alarm and Signaling Code.
    - c. NFPA 101 – Life Safety Code.
    - d. NFPA 90A – Standard for the Installation of Air-Conditioning and Ventilating Systems.
    - e. NFPA 92 – Standard for Smoke Control Systems.
    - f. NFPA 13 – Standard for the Installation of Sprinkler Systems.
    - g. NFPA 17 – Standard for Dry Chemical Extinguishing Systems.
    - h. NFPA 20 – Standard for the Installation of Stationary Pumps for Fire Protection.
    - i. NFPA 720 – Standard for the Installation of Carbon Monoxide (CO) Detection and Warning Equipment.
  - 2. UL Standards
    - a. UL 864 – Standard for Control Units for and Accessories for Fire Alarm Systems.
    - b. UL 268 – Smoke Detectors for Fire Alarm Systems.
    - c. UL 268A – Standard for Smoke Detectors for Duct Application.
    - d. UL 521 – Standard for Heat Detectors for Fire Protective Signaling Systems.
    - e. UL 228 – Standard for Door Closers-Holders, With or Without Integral Smoke Detectors.
    - f. UL 464 – Audible Signaling Devices for Fire Alarm and Signaling Systems, Including Accessories.
    - g. UL 346 – Standard for Waterflow Indicators for Fire Protective Signaling Systems.
    - h. UL 1971 – Standard for Signaling Devices for the Hearing Impaired.
    - i. UL 1481 – Standard for Power Supplies for Fire Protective Signaling Systems.
    - j. UL 1635 – Standard for Digital Alarm Communicator System Units.
    - k. UL 2075 – Standard for Gas and Vapor Detectors and Sensors.
  - 3. Local: Redford Township.
  - 4. Federal Codes and Regulations.
  - 5. Americans with Disabilities Act (ADA).
  - 6. International Standards Organization (ISO):
    - a. ISO-9000.
    - b. ISO-9001.

#### 1.4 SYSTEM DESCRIPTION

- A. Provide an expansion of the existing fire detection and alarm system as indicated on Drawings and this specification.

#### 1.5 DESIGN AND PERFORMANCE REQUIREMENTS

- A. System shall be programmed to provide early detection of fire, to notify building occupants, summon local fire department, override HVAC operation, and activate auxiliary systems to inhibit the spread of smoke and fire and to facilitate the safe evacuation of building occupants.

#### 1.6 GENERAL

- A. Upon the activation of any area smoke detector, duct type smoke detector, heat detector, manual pull station, sprinkler waterflow, the following functions shall automatically occur:
  1. The internal audible device shall sound at the control panel or command center.
  2. The LCD display shall indicate all applicable information associated with the alarm condition including zone, device type, device location, and time/date.
  3. All remote or local annunciator LCD/LEDs associated with the alarm zone shall be illuminated.
  4. Activate visual strobes and audible appliances on general alarm evacuation.
  5. The visual strobe shall continue to flash until the system has been reset. The visual strobe shall not stop operating when the "Alarm Silence" is pressed.
  6. All automatic events programmed to the alarm point shall be executed and the associated outputs activated.
  7. Transmit signal to the central station with point identification.
  8. Where required by code, appropriate HVAC equipment shall be turned off until system is reset.

#### 1.7 DUCT TYPE SMOKE DETECTOR ALARM

- A. Upon alarm activation of any duct type smoke detector the following functions shall automatically occur:
  1. The internal audible device shall sound at the control panel or command center.
  2. The LCD display shall indicate all applicable information associated with the alarm condition including zone, device type, device location, and time/date.
  3. All remote or local annunciator LCD/LEDs associated with the alarm zone shall be illuminated.
  4. Activate visual strobes and audible appliances on general alarm evacuation.
  5. The visual strobe shall continue to flash until the system has been reset. The visual strobe shall not stop operating when the "Alarm Silence" is pressed.
  6. All automatic events programmed to the alarm point shall be executed and the associated outputs activated.
  7. Transmit signal to the central station with point identification.
  8. Appropriate HVAC equipment shall be turned off until system is reset.

#### 1.8 SUBMITTALS

- A. Shop Drawings: For all system components.
  1. Data sheet indicating model number, performance specifications and dimensional data, color and finish.
  2. Details of construction and installation.
  3. Name of manufacturer.
  4. Full system schematic.
  5. Wiring details.
  6. Point-to-point wiring diagram showing all equipment.
  7. Battery calculations.
  8. Floor plan indicating fire alarm system devices only.
  9. Dimension plan indicating all items located inside fire alarm control panel. Plan should indicate future space.
  10. Indicate all features indicated in this specification which are not included in the manufacturer's equipment. Label these items as "Exceptions to the Specifications".

- B. Layout drawings (plans) identifying all fire detection and alarm system devices. Plans shall be to scale and indicate mounting height for each device.

#### 1.9 QUALITY ASSURANCE

- A. Fabrication and Installation Personnel Qualifications:
  - 1. Trained and experienced in the fabrication and installation of the materials and equipment.
  - 2. Knowledgeable of the design and the reviewed submittals.
  - 3. NICET Level 2 certified.
- B. Manufacturer:
  - 1. At least 5 years experience with approved systems.
  - 2. Having authorized service facility within 50 miles of Site.
- C. Components: All components shall be UL listed for intended use.
- D. Manufacturer's Services:
  - 1. Manufacturer's Certificate:
    - a. Submit for installed system.
    - b. Required Assurances:
      - 1) Confirmation of final inspection.
      - 2) Installation conforms to Specifications and Manufacturer's requirements.
  - 2. Provide Owner training program.

#### 1.10 DELIVERY, STORAGE AND HANDLING

- A. Deliver all materials in original, unbroken, brand marked containers or wrapping as applicable.
- B. Handle and store materials in a manner which will prevent deterioration or damage, contamination with foreign matter, damage by weather or elements, and in accordance with Manufacturer's directions.
- C. Store materials indoors and protect from weather. When necessary to store outdoors, elevate materials above grade and enclose with durable, watertight wrapping.
- D. Reject damaged, deteriorated, or contaminated materials and immediately remove from the Site. Replace rejected material with new materials at no additional cost to Owner.

#### 1.11 WARRANTY

- A. The Contractor shall warranty all materials, installation and workmanship for 1 year from date of acceptance, unless otherwise specified.
- B. A copy of the Manufacturer's warranty shall be provided with close-out documentation and included with the operation and installation manuals.
- C. The System Supplier shall maintain a service organization with adequate spare parts stock within 75 miles of the installation.
- D. Any defects that render the system inoperative shall be repaired within 24 hours of the owner notifying the contractor.

#### 1.12 CLOSE OUT

- A. Close out submittals shall include:
  - 1. Project specific operating manuals covering the installed fire detection and alarm system.
  - 2. Manufacturer's data sheets and installation manuals/instructions for all equipment supplied.
  - 3. Owner's instruction and operation manual.

4. Record drawings consisting of: a scaled plan of each building showing the placement of each individual item of the fire detection and alarm system as well as raceway size and routing, junction boxes, and conductor size, quantity, and color in each raceway.
5. All drawings must reflect point to point wiring.
6. All drawings shall be provided in standard .DXF format. A vellum plot of each sheet shall also be provided.
7. The application program listing for the system as installed at the time of acceptance by the building owner and/or local AHJ (disk, hard copy printout, and all required passwords).
8. Provide the name, address, and telephone of the authorized factory representative.
9. A filled out Record of Completion similar to NFPA 72, 1999 edition figure 1-6.2.1.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURER

- A. Contractor shall pay for all fire alarm design, parts, calculations, fees, wiring, and commissioning.
- B. Provide products manufactured by one of the following Manufacturers:
  1. Honeywell International – Kate Dehrmann-Zupan, [katherine.dehrmannzupan@honeywell.com](mailto:katherine.dehrmannzupan@honeywell.com), 216.347.0927.
    - a. Contact Dehrmann-Zupan for their fee to include in your quotation.
  2. No alternates will be acceptable.

### 2.2 INITIATING DEVICES

- A. Analog Addressable Smoke Detectors – General:
  1. Each Analog addressable smoke detector's sensitivity shall be capable of being programmed individually as most sensitive, more sensitive, normal, less sensitive, or least sensitive.
  2. In addition to the five sensitivity levels the detector shall provide a prealarm sensitivity setting, which shall be settable in 5% increments of the detector's alarm sensitivity value.
  3. The detector shall provide a maintenance alert signal that 75% to 99% compensation has been used.
  4. The detector shall provide a dirty fault signal that 100% greater compensation has been used.
  5. The system shall allow for changing of detector types for service replacement purposes without the need to reprogram the system.
- B. Smoke Detectors:
  1. Smoke detectors shall be dual type, with visible LED alarm light.
  2. Separate mounting base and detachable sensor head.
- C. Duct Detector Housing:
  1. Provide smoke detector duct housing assemblies with air sampling tube sized for duct location to mount an analog addressable detector.
  2. Mounting base with auxiliary relay.
  3. Provide remote alarm LED indicators and remote test station for each duct type smoke detector.
  4. Wired and installed by Electrical Subcontractor. Coordinate exact location with Mechanical Subcontractor.
- D. Heat Detectors:
  1. Analog/Addressable Combination, Fixed Temperature/Rate of Rise:
    - a. Fixed Temperature: 135 degrees F (57 degrees C).
    - b. Rate of Rise: 15 degrees F (9 degrees C) per minute.
    - c. Analog/Addressable Fixed Temperature: 200 degrees F (94 degrees C).
    - d. Heat detector spacing shall comply with NFPA and Manufacturer's listing.
- E. Detector Bases: Provide standard detector mounting bases suitable for mounted on 1-gang, 3-1/2-inch or 4-inch octagon box, and 4-inch square box.

- F. Carbon Monoxide Detectors:
  - 1. Carbon monoxide detector listed for connection to fire-alarm system.
    - a. Mounting: Adapter plate for outlet box mounting.
    - b. Testable by introducing test carbon monoxide into the sensing cell.
    - c. Detector shall provide alarm contacts and trouble contacts.
    - d. Detector shall send trouble alarm when nearing end-of-life, power supply problems, or internal faults.
    - e. Comply with UL 2075.
    - f. Locate, mount, and wire according to manufacturer's written instructions.
    - g. Provide means for addressable connection to fire-alarm system.
    - h. Test button simulates an alarm condition.
- G. Manual Pull Stations: Shall be analog/addressable, single action double action, single stage, recessed pull-lever, break glass, open circuit type. Finish of the station to be red with lettered instructions "PULL IN CASE OF FIRE."
- H. Fire Protection Water Flow Switches and Valve Tamper Switches:
  - 1. To be provided by Fire Protection (Sprinkler) System Subcontractor in accordance with Division 21.
  - 2. For each switch, provide addressable module to monitor status of switch.
- I. Combination Smoke/Fire Dampers:
  - 1. To be provided by Mechanical Subcontractor in accordance with Division 21.
  - 2. For each combination smoke fire damper, provide duct type smoke detector or area smoke detector with auxiliary contacts or addressable control module to initiate respective damper to close.
  - 3. To control multiple smoke/fire dampers together, provide additional 20A relays as required.
- J. Addressable Relays/Monitor and Control Modules: Form C normally open/normally closed dry relay contacts rated at 24VDC at 2 amps.

## 2.3 NOTIFICATION APPLIANCES

- A. Low Profile Horn Strobes/Low Profile Strobes:
  - 1. Provide wall mounted horn/strobe with audible output of 84dBA at 10 feet.
  - 2. Horn shall have a selectable steady or synchronized temporal output and shall be wired separately from strobes.
  - 3. Strobes shall provide synchronized flash outputs.
  - 4. Wall mounted strobe Candela ratings of 15cd, 30cd, 60cd, 75cd, 110cd. Candela ratings shall be determined by equipment supplier.
  - 5. Ceiling mounted strobe Candela ratings of 15cd, 30cd, 75cd, 90cd, 115cd, 150cd, and 177cd Candela ratings shall be determined by equipment supplier.
- B. Low Profile Speaker Strobes/Low Profile Strobes:
  - 1. Provide wall mounted speaker/strobe with audible output of up to 96 dBA from 10 feet.
  - 2. Speakers shall be wired separately from strobes.
  - 3. Strobes shall provide synchronized flash outputs.
  - 4. Wall mounted strobe Candela ratings of 15cd, 30cd, 60cd, 75cd, 110cd. Candela ratings shall be determined by equipment supplier.
  - 5. Ceiling mounted strobe Candela ratings of 15cd, 30cd, 75cd, 90cd, 115cd, 150cd, and 177cd Candela ratings shall be determined by equipment supplier.

## PART 3 - EXECUTION

### 3.1 WIRING

- A. All wiring shall be in accordance with Manufacturer's written recommendations and shall meet all applicable code requirements.
- B. All wiring shall be copper.

- C. No. 16 AWG minimum for signaling line circuits (SLCs)
- D. No. 14 AWG THHN minimum for audible and visual notification appliance circuits (NACs).
- E. No. 12 AWG THHN minimum for line voltage.
- F. Install wiring completely in metal raceways in accordance with Division 26 Section "Raceways for Electrical Systems."
- G. Install wiring partially in metal raceways in accordance with Division 26 Section "Raceways for Electrical Systems." Provide junction boxes and conduit sleeves to main corridor areas. Install wiring in conduit sleeves to above ceiling in corridor areas. Wiring in corridor areas does not need to be installed in conduit. Provide cable tray, cable supports, nylon straps as required to properly support cabling in accordance with code .
- H. Cable type shall be FPLP, FPLR.

### 3.2 EQUIPMENT INSTALLATION

- A. Manual Pull Stations: Unless otherwise indicated, mount semi-flush in recessed back boxes.
- B. Fire Protection Water Flow Switches and Valve Tamper Switches: To be installed in accordance with Division 21 Section "Water Based Fire Protection Systems." Provide wiring and connections for each flow and tamper switch required to be supervised.
- C. Duct Smoke Detectors: Connect each duct detector to fire alarm system so upon sensing smoke, fire alarm system goes into alarm. Coordinate location with Mechanical Subcontractor.
- D. Heat Detectors: Install at Manufacturer's listed spacing as determined by ceiling height in protected rooms.
- E. Smoke Detectors: Install detectors indicated to be ceiling mounted not less than 4 inches from a side wall to the near edge. Install detectors located on the wall at least 4 inches but not more than 12 inches below the ceiling. For exposed solid joist construction, mount detectors on the bottom of the joists. On smooth ceilings, install detectors not over 30 feet apart in any direction. Install detectors no closer than 5 feet from air registers.
- F. Audio/Visual Alarm Indicating Devices: Mount at 80 inches above the highest floor level within space or 6 inches below the ceiling, whichever is lower. Unless otherwise indicated, install bells and horns on flush-mounted back boxes with the device operating mechanism concealed behind a grille. Combine audible and visible alarms at the same location into a single unit.

### 3.3 GROUNDING

- A. Ground equipment and conductor and cable shields. For audio circuits, minimize to the 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.

### 3.4 FIELD QUALITY CONTROL

- A. All intelligent analog addressable devices shall be tested for current address, sensitivity, and user defined message.
- B. All wiring shall be tested for continuity, shorts, and grounds before the system is activated.
- C. All test equipment, instruments, tools, and labor required to conduct the tests shall be made available by the installing contractor.

- D. The system including all its sequence of operations shall be demonstrated to the Owner, his representative, and the local fire inspector. In the event the system does not operate properly, the test shall be terminated. Corrections shall be made and the testing procedure shall be repeated until it is acceptable to the Owner, his representatives and the fire inspector.
- E. At the final test and inspection, a factory trained representative of the system manufacturer shall demonstrate that the system functions properly in accordance with these specifications. The representative shall provide technical supervision, and participate during all of the testing for the system.
- F. All fire alarm testing shall be in accordance with National Fire Alarm and Signaling Code, NFPA 72.
- G. A letter from the Contractor certifying that the system is installed entirely in accordance with the system manufacturer's recommendations and within the limitations of the required listings and approvals, that all system hardware and software has been visually inspected and functionally tested by a manufacturer's certified representative, and that the system is in proper working order.

END OF SECTION 28 31 00